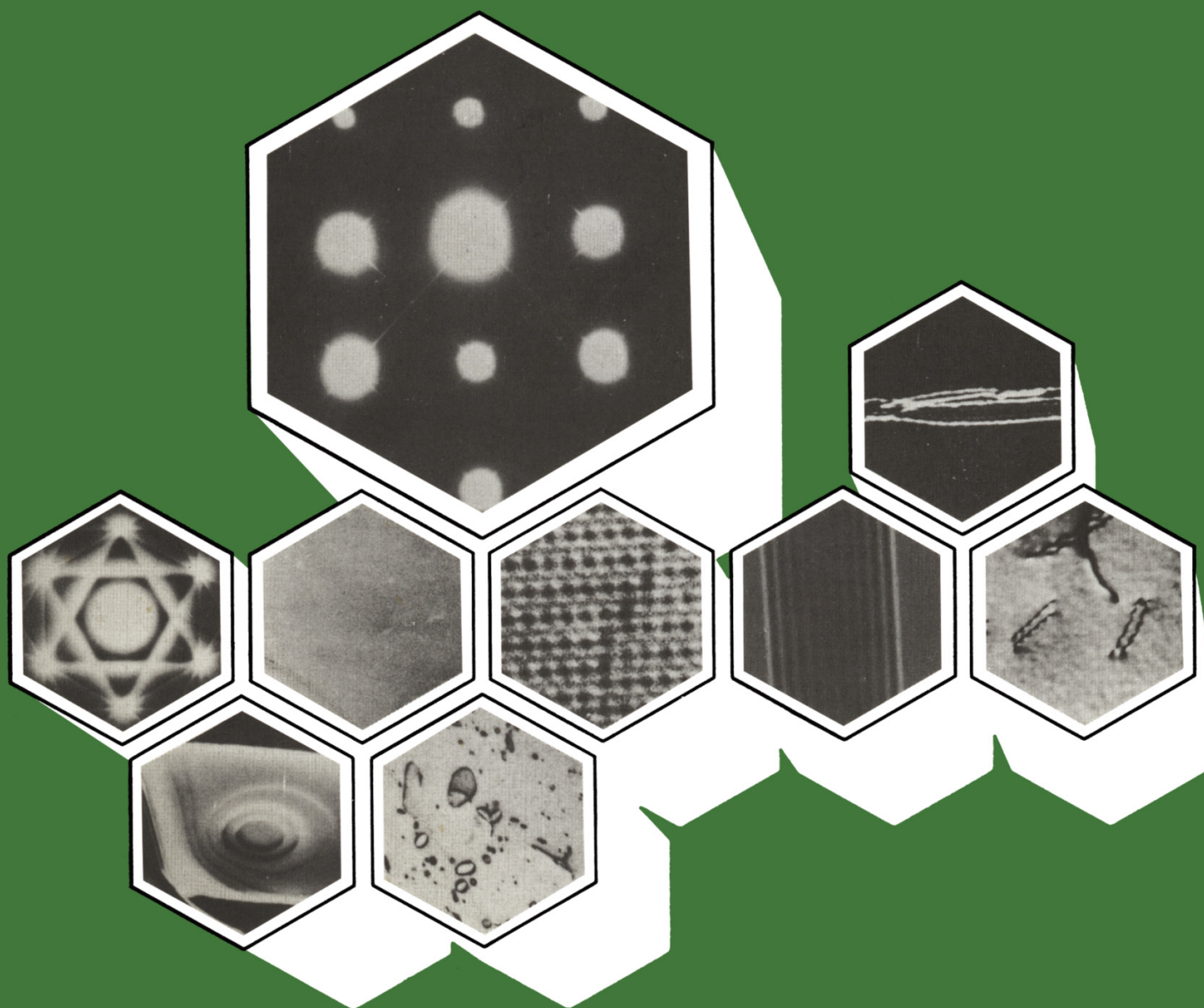


**PRACTICAL ELECTRON
MICROSCOPY
IN
MATERIALS SCIENCE**

5 Monograph Five
**Electron Microscope
Specimen Preparation
Techniques in
Materials Science**

**K C Thompson-
Russell
and
J W Edington**



**MACMILLAN
Philips Technical Library**

5

**ELECTRON MICROSCOPE
SPECIMEN PREPARATION TECHNIQUES
IN MATERIALS SCIENCE**

Already published in this series:

1. *The Operation and Calibration of the Electron Microscope*
2. *Electron Diffraction in the Electron Microscope*
3. *Interpretation of Transmission Electron Micrographs*
4. *Typical Electron Microscope Investigations*

Philips Technical Library

*Monographs in Practical Electron Microscopy
in Materials Science*

5

**ELECTRON
MICROSCOPE SPECIMEN
PREPARATION TECHNIQUES
IN MATERIALS SCIENCE**

K. C. THOMPSON-RUSSELL

Philips' Gloeilampenfabrieken, Eindhoven, Holland

and

J. W. EDINGTON

Professor of Mechanical, Aerospace and Materials Engineering, University of Delaware, U.S.A.

M

© N. V. Philips' Gloeilampenfabrieken, Eindhoven, 1977

All rights reserved. No part of this publication
may be reproduced or transmitted, in any form
or by any means, without permission

ISBN 978-1-349-03405-5 ISBN 978-1-349-03403-1 (eBook)
DOI 10.1007/978-1-349-03403-1

First published 1977 by
THE MACMILLAN PRESS LTD
London and Basingstoke
Associated companies in New York Dublin
Melbourne Johannesburg and Madras



PHILIPS

Trademarks of Philips' Gloeilampenfabrieken

This book is sold subject to the standard conditions of the
Net Book Agreement

CONTENTS

<i>Preface</i>	vi
<i>Acknowledgements</i>	vii
1 INTRODUCTION	1
2 PREPARATION OF THIN FOILS FROM BULK MATERIAL	1
2.1 The Window Technique	2
2.2 The Disc Technique (Electropolishing)	4
2.3 The Disc Technique (Ion-Beam Thinning)	7
2.4 Chemical Polishing	8
2.5 Specialised Techniques	8
2.6 Specimen Washing, Storage and Insertion into the Electron Microscope	10
2.7 Selection of Specimen Preparation Technique	10
2.8 Power Supplies for Electropolishing	10
2.9 Cooling Baths	11
3 ARTEFACTS IN THIN FOILS	12
4 REPLICAS	15
4.1 High-Resolution Replicas of Metals/Alloys	15
4.2 Replication of Polymers	17
4.3 Extraction Replicas	17
5 PREPARATION OF HIGH-RESOLUTION TEST SPECIMENS	19
5.1 Single-Crystal (100) Gold Films	19
5.2 Partially Graphitised Carbon Black	19
5.3 Replicas for Point to Point Resolution Tests	19
6 SAFETY	22
6.1 Cyanides	22
6.2 Hydrogen Fluoride	22
6.3 Hazards in Electropolishing	23
6.4 Other Reactive Solutions	24
7 STRENGTHS AND PURITIES OF CHEMICALS	24
8 REFERENCES TO SECTIONS 1 TO 7	24
9 TABLES OF SPECIMEN PREPARATION TECHNIQUES	26
9.1 Elements and compounds	26
9.2 Glasses	102
9.3 Polymers and other organic materials	104
9.4 Extraction replica methods for metals	108
10 REFERENCES FOR SECTIONS 9.1 TO 9.4	111
<i>Index</i>	135

PREFACE

This book consists of a short introduction to the more important transmission electron microscope specimen preparation techniques, together with a comprehensive list of these methods for specific materials taken from the literature up to the end of 1975.

If the material of interest has been prepared before, the method will be found in the tables in section 9 under the appropriate material's heading. Usually several alternatives are listed. It may be necessary to try the full range until a satisfactory result is obtained because the reproducibility of the results appears to vary from one laboratory to another. For an unlisted material, success is usually obtained by using the technique for the material with the closest composition, and varying only slightly parameters such as electrolyte composition, applied electrical potential, ion gun conditions, etc. Sometimes this approach may be unsuccessful for electropolishing. If so, find solutions for the constituent elements and select that with the most common components. However, considerable experimentation with composition of the solution and applied electrical conditions may be necessary before success is obtained. To facilitate this process, a large number of electropolishing solutions are included in section 9.1.

In some cases artefacts may be introduced during specimen preparation. If it is suspected that this is occurring, compare the results of several approaches.

It must be emphasised that serious accidents can happen with mixtures of chemicals, particularly when an electrical potential is applied. Consequently, considerable care must be taken at all times, particularly with the solutions mentioned in section 6. Every effort has been made to give reliable information on safety and first aid. However, neither the authors nor the publishers can assume responsibility for the validity of the precautions or the consequences of their use. The objective has been to point out the dangers and to furnish the best guides available relative to safety.

Eindhoven and Delaware, 1977

K. C. T.-R.
J. W. E.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge useful discussions with Dr. P. Doig and the help of Mrs. Marion Campbell with the literature survey.

They would like to thank the following research workers for providing figures: D. W. Boreland, R. H. Bricknell, J. D. Boyd, G. T. Hahn, R. Nauta, D. Porter, A. R. Rosenfield, D. J. Rowcliffe, F. Sheldon, H. van Wijngaarden and D. B. Williams.

Thanks are due to the following journals for permission to reproduce some of the figures: *Metallurgical Transactions* (figures 17a and 23), *Journal of Materials Science* (figure 14) and *Trans. Quarterly A.S.M.* (figure 17b).

5. ELECTRON MICROSCOPE SPECIMEN PREPARATION TECHNIQUES IN MATERIALS SCIENCE

1. INTRODUCTION

The aim of electron microscopy is to produce good micrographs which enable the defect structure of the specimen to be accurately studied and convincingly illustrated in reports and publications. It cannot be over emphasised that good specimen preparation is the key to producing good electron micrographs. Consequently, it is *essential* to perfect a suitable specimen preparation technique before embarking upon a detailed microstructural investigation.

In studying the microstructure of bulk material, thin foils may be produced by a variety of techniques, the most useful of which are discussed here. In addition replicas may be used for surface studies but scanning electron microscopy has, to a large extent, superseded this technique except for specialised requirements. Consequently, only a short discussion of replica techniques is included.

2. PREPARATION OF THIN FOILS FROM BULK MATERIAL

Specimen preparation falls naturally into the following two stages.

Production of thin sheet approximately $1\text{cm} \times 1.5\text{cm} \times 0.1\text{--}0.5\text{mm}$ thick (Stage 1)

This is usually achieved by direct rolling of ductile materials. Alternatively, slices may be cut from bulk material, using either a slitting wheel or a spark machine, followed by grinding, mechanical polishing, then chemical or electropolishing to remove the damaged surface layers. These processes are relatively standard and will not be discussed here. Reference may be made to Goodhew (1973) for further details.

Production of an electron-transparent thin foil from the sheet (Stage 2)

Frequently the sheet is electro- or chemically polished directly until small portions are electron transparent (window technique). These may be cut off and viewed directly in the microscope. Alternatively, small discs that fit the microscope specimen holder exactly may be machined from the sheet, then thinned locally in the centre, using one of several methods to produce a small hole surrounded by electron transparent material (disc technique).

These two approaches are discussed in the following sections.

The technique employed for both stages 1 and 2 will depend upon the nature of the problem to be studied. Two typical cases would be:

1. Microstructure that may be produced readily in a thin sheet or disc, yet remaining representative of the bulk, e.g. a precipitate formed during ageing.
2. Microstructure that can only be produced in the bulk, and must be preserved throughout specimen preparation, e.g. a deformed creep specimen.

Typical sequences of events for these two cases are shown in figure 1.

It is important to consider the possible influence of the specimen preparation technique itself on the details of the microstructure observed in the microscope. Thus, if it is desired to preserve microstructure in a tensile specimen through a slicing and grinding sequence, it will be essential to determine the depth of near-surface damage produced by these processes. Then the specimen must be made slightly thicker than twice the damage penetration depth so that the thinned central region is unaffected. The best method of determining the damage penetration

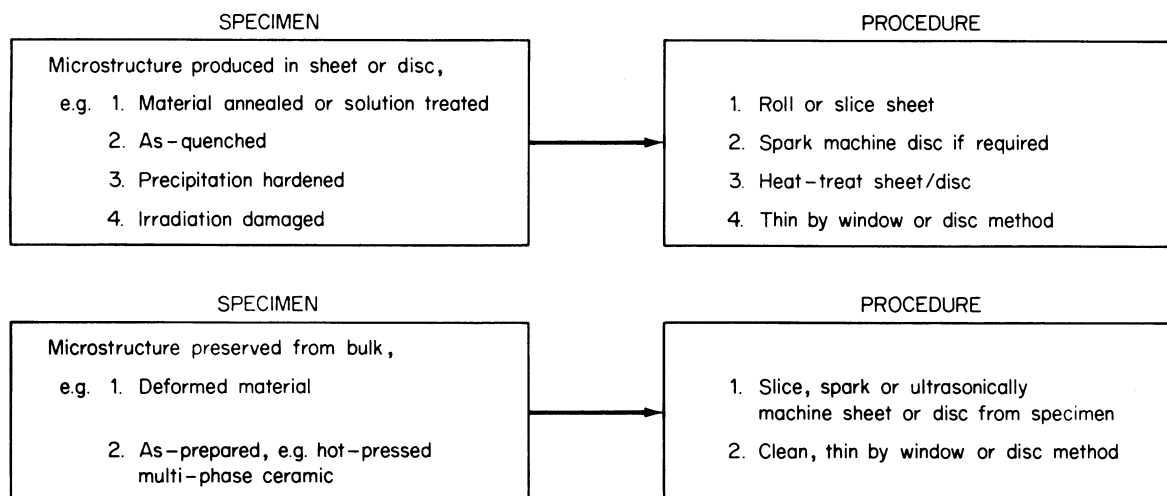


Figure 1 Typical sequences of events for the production of specimens suitable for transmission electron microscopy

depth is to use fully annealed material with a low defect density, and prepare successively thinner sections using the proposed slicing/grinding technique before thinning. The specimen thickness at which damage appears in the thin foil may be readily determined from a change in the dislocation configurations and density.

Whitton (1965) showed that vibratory polish damage penetration can be $< 25\text{nm}$ in W, Ta and Zr, or even less in ceramics. In contrast Stickler and Booker (1963) have shown that damage can extend to a depth of $25\mu\text{m}$ in silicon on grinding with 600 grade silicon carbide paper. Hockey (1970) has reported damage in alumina crystals extending from $1\text{--}2\mu\text{m}$, with $0.25\mu\text{m}$, diamond grit polish, to approx. $10\mu\text{m}$ for grinding with a 325 grade diamond-grit-impregnated wheel. Jansen and Zeedijk (1972) demonstrated that damage in an $0.2\%\text{C}$ steel penetrated to a depth of $75\mu\text{m}$ for spark machining and $45\mu\text{m}$ for grinding. In soft materials spark machining or grinding damage can easily extend to depths of approx. 0.1mm unless considerable care is taken.

Sheet or disc material suitable for the final stage 2 of the specimen preparation must first be cleaned. Generally the surface should be degreased using carbon tetrachloride, then lightly etched. Suitable etches for many materials have been compiled by Richardson (1971) and Smithells (1967). Some polishes/etches from sections 9.1 and 9.4 may also be suitable. Any surface oxide arising from heat treatment must be removed, either by light grinding with fine (600 grade) emery paper or by etching. In stage 2, the thinner the starting material, the cleaner the surface and the simpler the technique, the better the results will be. Cleanliness is *extremely* important. When using rubber gloves avoid talcum powder because it will always find its way to the specimen

and contaminate it. All solutions should be covered to avoid contamination by dust.

2.1 The Window Technique

This is a simple electropolishing technique applicable to a very wide range of metals and alloys, and produces large thin areas. A piece of sheet $0.1\text{--}0.5\text{mm}$ thick and approx. 1cm square is spot welded to thin platinum (thermocouple) wire or held in tweezers. All submerged parts of the holder and edges of the specimen are painted with acid-resisting lacquer* (figure 2). The specimen is made the anode in a simple cell (figure 3) whose cathode has a much larger area and is usually a large-bore platinum/stainless steel tube or wire-mesh cylinder. The specimen is held in the centre of the beaker (capacity approx. 200cm^3) so that it may be withdrawn for inspection without delay (figure 3).

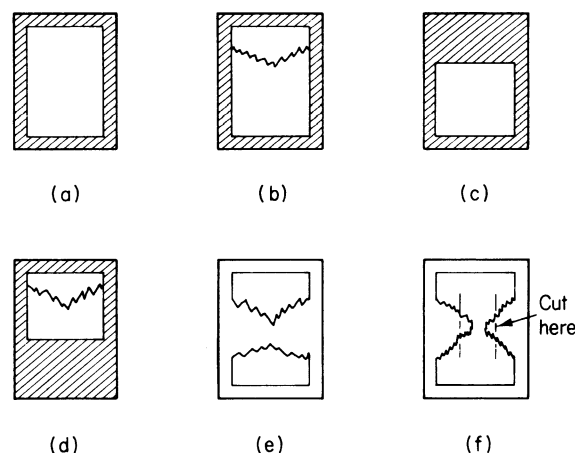


Figure 2 Typical stages in electropolishing sheet material using the window technique. The shaded regions a-d are lacquered

* Available from W. Canning and Co. Ltd., 77 St. John Street, Clerkenwell, London, WC1, U.K.

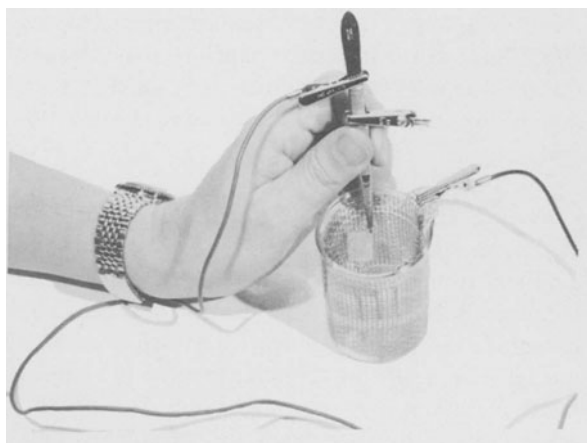


Figure 3 Typical electropolishing cell with a stainless steel wire mesh cathode and a window specimen held in tweezers

Usually the solution is gently stirred to prevent local heating around the specimen. Alternatively the specimen may be gently moved up and down in the solution.

During polishing the solution must be maintained at the required temperature, and the voltage set constant (see later in this section). Typical stages during polishing are shown schematically in figure 2. Perforation usually occurs first at the top of the specimen (figure 2b). After the first perforation the specimen is relacquered* as shown in figure 2c, inverted, and polished to a second perforation (figure 2d), when the lacquer may be stripped (see section 2.6). Polishing is then continued until the two holes just meet (figure 2f). Then the specimen is rapidly removed and washed immediately (see section 2.6). Normally the voltage is not switched off until washing is begun, which ensures that polishing conditions are maintained during removal of the

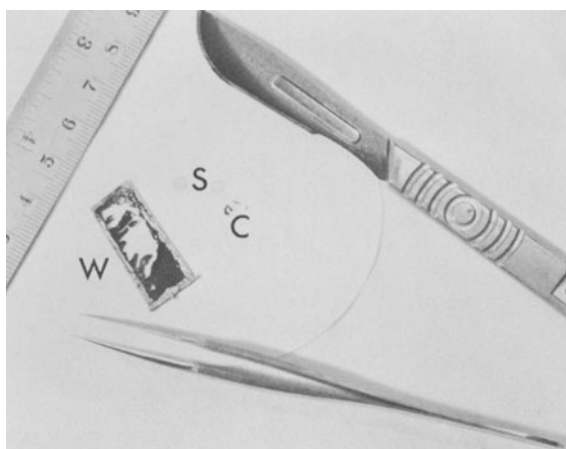


Figure 4 Finished window specimen W with support grids S and cut specimens C. Scalpel and tweezers are also shown

specimen from the electropolish. The tongues of thin material marked in figure 2f are cut off with a sharp scalpel. A typical cut specimen is shown in figure 4, together with a window specimen, scalpel and specimen mounting grid.

During the later stages of polishing, when close to the formation of the tongues, avoid removing the specimen from the electrolyte for more than 1 s. Polishing conditions may not be re-established immediately on re-immersion if the layers of electrolyte on the specimen surface are disturbed, whereupon the foils will be unsatisfactory. During short-term removal it is not necessary to switch off the applied voltage.

Typical relationships between the specimen current density and specimen potential are shown schematically in figure 5a for a cell such as that shown in figure 3. This type of relationship can only

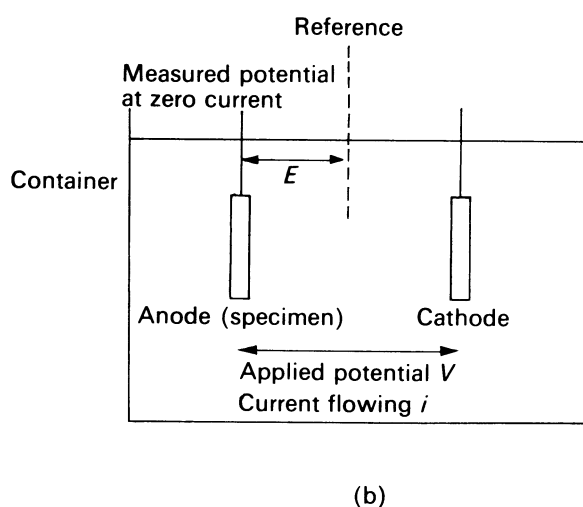
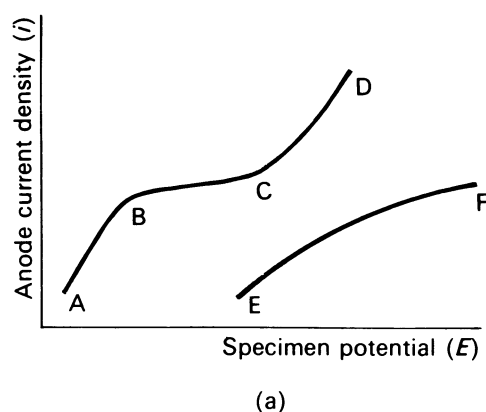


Figure 5 (a) Anode current density i vs. specimen potential E . Curve ABCD shows a polishing plateau BC whereas curve EF does not. (b) Schematic diagram illustrating potentiostatically controlled electropolishing

* Since preferential polishing usually occurs at the edge of the lacquered region, it is sometimes useful to lacquer small regions of the sheet to induce perforation in several places. The window specimen in figure 4 has been polished using this approach.

be measured using potentiostatic techniques (West, 1970), i.e. those that measure the specimen potential relative to a fixed electrode potential by using a reference standard electrode, e.g. saturated calomel. The schematic diagram in figure 5b shows the electropolishing cell with the reference electrode in position. Within the cell a voltage V is applied between anode and cathode producing a current density i on the specimen (anode). The anode potential E , governed by i , is measured with reference to the standard electrode at zero current. As V is varied, i changes, producing a change in E enabling the relationship between i and E in figure 5a to be obtained. In the cell, V does not correspond to E because the potential of *both* the cathode and anode varies with current flow. In practice, therefore, the relation between the applied voltage V and current i in the cell does not necessarily show a well-defined plateau. Consequently, in order to determine the polishing conditions it is necessary to determine the $E-i$ curve (figure 5a), using a potentiostat, then polish at the applied voltage V corresponding to the plateau BC. Alternatively, if a potentiostat is not available, a series of specimens* may be polished, each for a period (e.g. 5 min) at a different applied voltage. Polishing conditions may then be detected optically using a low-magnification microscope.

The curve EF represents the current density/potential relationship at higher temperature when an electropolishing plateau is not obtained. Since this behaviour may occur at room temperature many solutions are used at low temperatures, where there is a plateau, and where the polishing rate is reduced to a reasonable level. There may be a specific voltage on the EF curve at which polishing occurs. This may be determined by trial and error using a series of specimens, as outlined earlier.

It is frequently useful, but not essential, to employ potentiostatic control of the electrical conditions in the cell *during* electropolishing. This automatically compensates for small fluctuations in E or i during polishing and produces increased areas of thin foil (Ginn and Brown, 1965). However, almost as much improvement may be obtained at much less cost by using a constant-voltage power supply with a low ripple on the output (see section 2.8).

Typically, thin regions suitable for conventional transmission electron microscopy utilising diffraction contrast should extend approx. $10\mu\text{m}$ from the edge of the specimen and approx. $50\mu\text{m}$ along it. Thus a section through the edge of the specimen and normal to its surface should be a sharp wedge. Preferably the thin area should be larger than specified above, unless there are special constraints, i.e. the specimen may have a very high atomic

number which significantly lowers penetration and therefore reduces the thin area for a given wedge angle. It is further important to produce the cleanest surface possible, which requires very careful washing, drying and storage of the specimen (see section 2.6).

2.2 The Disc Technique (Electropolishing)

Disc-type specimens are usually 2.3 or 3mm in diameter to fit snugly into the electron microscope specimen holder. An initially flat disc may be dished to perforation in the centre by a variety of techniques. The electron transparent region is a narrow band of material around the hole. The primary advantages of this approach are specimen robustness due to the thick outer rim, and efficiency of utilisation of material.

There have been a very large number of methods described for thinning disc specimens (Goodhew, 1973) but only the most useful are discussed here. One of the earliest, due to Dewey and Lewis (1963), was the 'p.t.f.e. holder' in which the disc was tightly clamped so that the solution was prevented from reaching the specimen edges (figure 6a). The end of the holder containing the specimen was then immersed in the electrolyte, which was sometimes stirred, and the specimen electropolished to perforation as in the window technique. However, more modern techniques involve a jet of polishing solution which

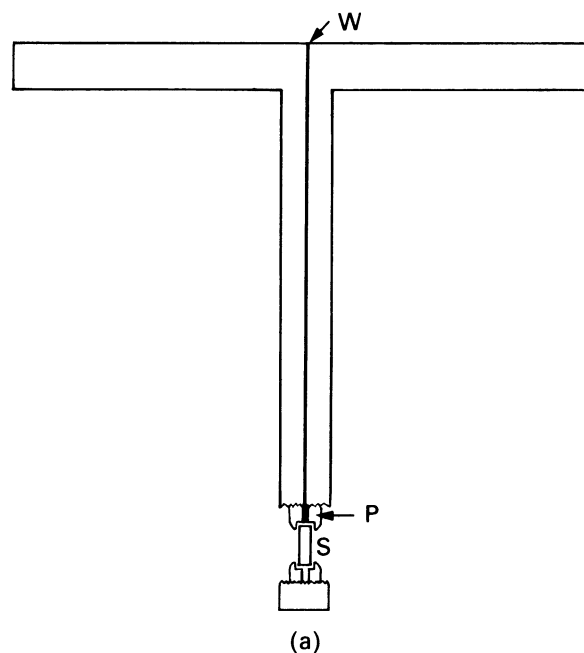


Figure 6 (a) Schematic diagram of a p.t.f.e. holder; all of the holder is constructed of the insulator p.t.f.e. with connecting wire W running to a disc specimen S held between shaped p.t.f.e. washers P . (b) Submerged-jet electrically insulating specimen holder D with electrical connection W to the metal rod R . A screw-in electrically insulating washer P and typical discs S are shown

* Use fully annealed coarse-grain-size material which is easier to polish than deformed material.

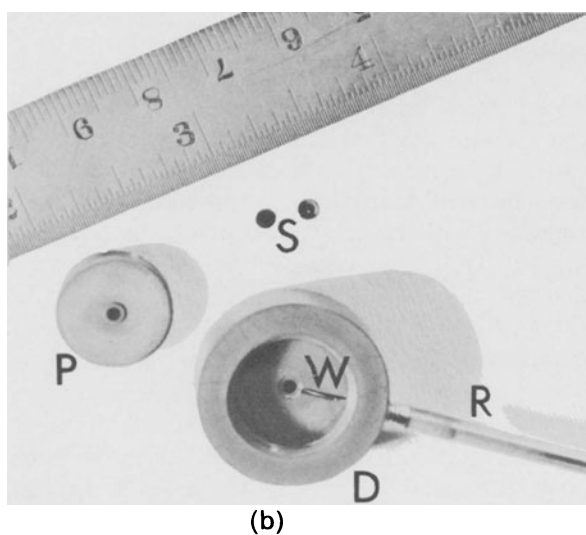


Figure 6 (continued)

strikes the surface of the specimen and produces a more rapid rate of attack in its centre. Either a single-stage or a two-stage process to perforation may be used, as described below.

Single-Stage Processes

These are generally most effective when the disc is reasonably thin to begin with, e.g. approx. 0.1mm. Like the p.t.f.e. holder, the disc is held tightly clamped in a special holder (figure 6b). The specimen is then made the anode of a simple cell and electropolished until perforation occurs, when it is washed, dried and mounted directly in the microscope holder. Preferential polishing at the centre is induced by submerged jets* (Schoone and Fischione, 1966).

More recently a single-stage jet thinning technique has been developed which enables low electrical conductivity specimens to be prepared† (Bainbridge and Thorne, 1970). This technique is shown schematically in figure 7. The specimen is mounted between two jets of electrolyte in separate cells such that the specimen forms the electrical connection between the two positive and negative electrodes via the electrolyte jets. During polishing the jets are maintained by a peristaltic pump and the polarity of the cell is reversed at intervals of 1 min. The advantages claimed for this technique are its wide applicability to ceramics and metals, together with the preservation of the wedge profile after thinning, so that immediate stopping after perforation is unnecessary.

With all approaches, except that of Bainbridge and Thorne (1970), it is necessary to stop polishing and wash the specimen immediately on perforation

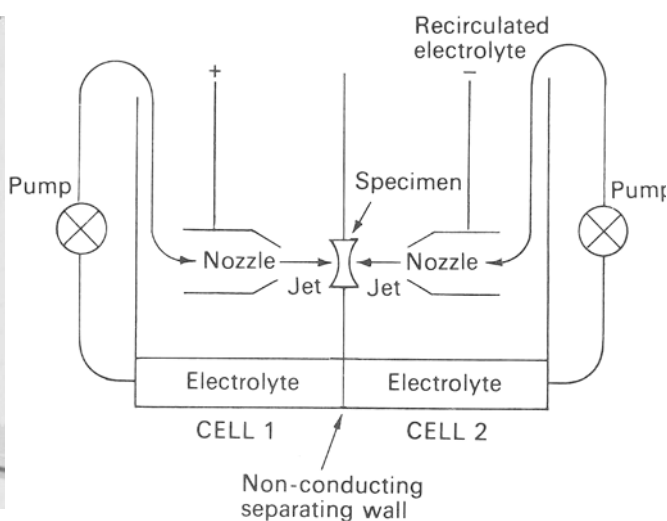


Figure 7 Schematic diagram illustrating the action of an a.c. jet thinning technique due to Bainbridge and Thorne (1970)

because this point corresponds to the maximum thin area. Further polishing increases the wedge angle at the edge and drastically reduces the electron-transparent region. Perforation may be detected by continuous observation with a telescope using a light source behind the specimen. However, various automatic methods have been developed using light pipes and photo-detectors to stop polishing at the instant of perforation (Schoone and Fischione 1966, and Hill et al., 1968). Figure 8 shows a typical commercially available automatic electropolishing unit of this type, together with the specimen holder.

In all disc holders it is essential that the specimen

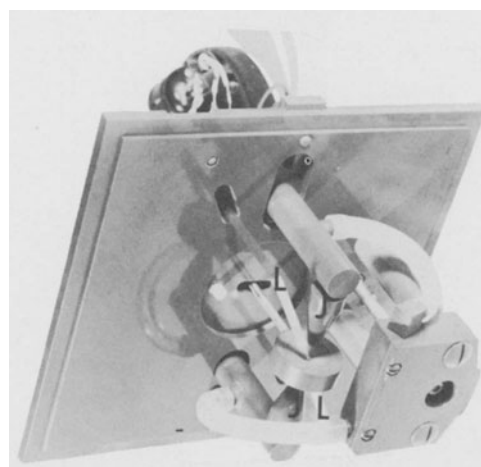


Figure 8 Submerged jet electropolishing apparatus manufactured by Fischione*. The specimen is held in the holder shown in figure 6b, electrolyte being circulated through the jets J. The light pipes L enable automatic shut-down on perforation of the disc

* E. A. Fischione, 7925 Thon Drive, Verona, Pa., U.S.A.

† Materials Science Northwest Ltd., 55 Cocker Street, Blackpool, Lancashire, England.

be tightly held in position, so that electrolyte does not penetrate behind the clamping washers. Otherwise local attack will occur at the edge of the specimen, preventing dishing in the centre.

Two-Stage Processes

This approach is generally used for thicker starting material (0.2–1.0mm) and involves a preliminary stage which massively dishes the specimen, then a final thinning stage to perforation at the centre. The initial stage usually involves a single or a double jet of electrolyte impinging on the specimen. A typical arrangement using a peristaltic pump to recirculate the electrolyte is shown schematically in figure 9. The equipment is used to dish from each side consecutively with the electrical connection being made to the stainless steel support grid. Alternatively, pairs of horizontal jets may be used and/or the specimen may be held in a p.t.f.e. or Schoone and Fischione-type holder. The latter is shown in figures 6b and 8.

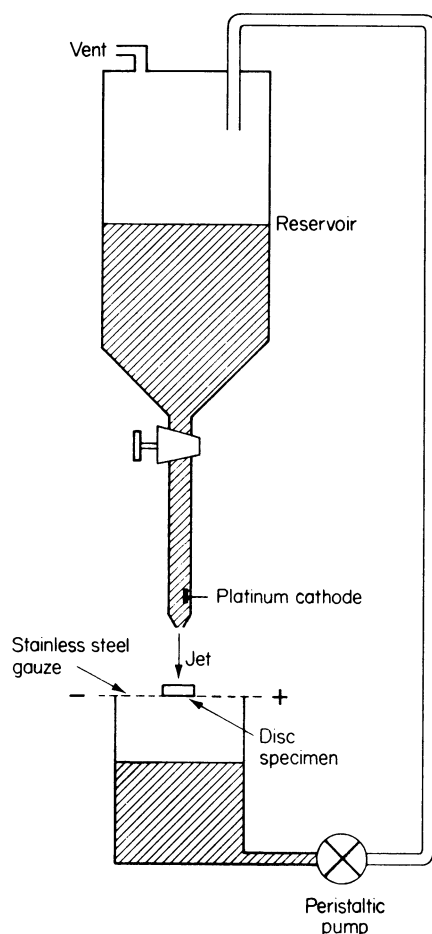


Figure 9 Schematic diagram of jet-indenting equipment

In operating jetting equipment, the diameter of the jet nozzle and its distance from the specimen must be carefully selected to produce satisfactory

polishing combined with the correct flat-bottomed dish shape. The largest jets used have been 1.3–1.5mm diameter (Stobbs 1969; Davis 1968; Youngblood, 1969) and the smallest 0.5mm diameter (Stobbs 1969; Kirchner 1969; Larsen et al., 1969). In general the largest diameter possible should be used, to maximise the amount of thin area, consistent with retaining a reasonably thick edge to the disc. Dubose and Steigler (1967) have reported that the shape of the dished region depends on voltage (figure 10), the best shape being obtained at intermediate voltages. In practice, the distance between the jet nozzle and disc is usually 1–10mm and may be adjusted to obtain polishing conditions, at such an intermediate voltage. Increasing the distance decreases the current for a given applied voltage.

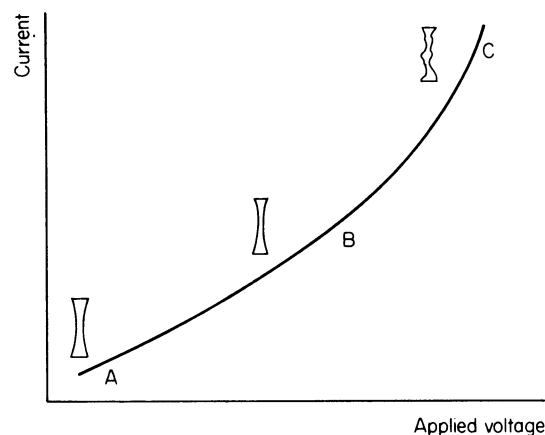


Figure 10 Disc profiles after jet indenting in regions A, B and C of the current voltage curve (from Dubose and Steigler, 1967)

Perforation in the non-submerged jet equipment of the type discussed here should be avoided because serious bending would occur with resulting deformation of the thin areas. Consequently, a final thinning stage must be employed. It is necessary to provide a suitable specimen approx. 0.05mm thick in the centre, without direct measurement of the thin region which, if a micrometer were used, would certainly introduce dislocations. Consequently it is necessary to calibrate the amount of material removed per second on dummy specimens.

Generally, the final thinning stage involves electrothinning techniques of the type discussed in this section, p. 4. The simplest method is to spot-weld a platinum wire to the disc, lacquer its edges, then electropolish, observing perforation with a telescope. Alternatively, a p.t.f.e. holder or equivalent may be used, in which case it is recommended that the initial jetting should be performed with the specimen mounted in the holder. If this is not done, the disc profile after jetting may be unsatisfactory for the holder, preventing satisfactory polishing during the final stage.

2.3 The Disc Technique (Ion-beam Thinning)

Ion-beam thinning enables electron transparent foils of brittle and/or non-conducting materials to be prepared reproducibly. A beam of 3–6kV ions is directed at the specimen and atoms or molecules are ejected from the specimen at the point of ion impingement. The rate of thinning depends on the relative masses of the ion and specimen atoms, the ion energy, the crystal structure of the specimen and the angle of incidence of the beam on the specimen. Argon is usually used as the bombarding species because it is the heaviest inert atom and is available at a reasonable cost. Figure 11 shows schematically the penetration and rate of thinning as a function of angle of incidence of the ion beam. During the initial stages of thinning the incident angle is chosen to give maximum thinning rate, but during the later stages it is reduced to produce minimum surface damage. Typical angles of incidence for Si, SiC or Si₃N₄ are 30° and subsequently <18°. It is sometimes an advantage to use short periods (15min) of ion-beam thinning to clean oxide from the surface of specimens previously produced by chemical polishing or electropolishing.

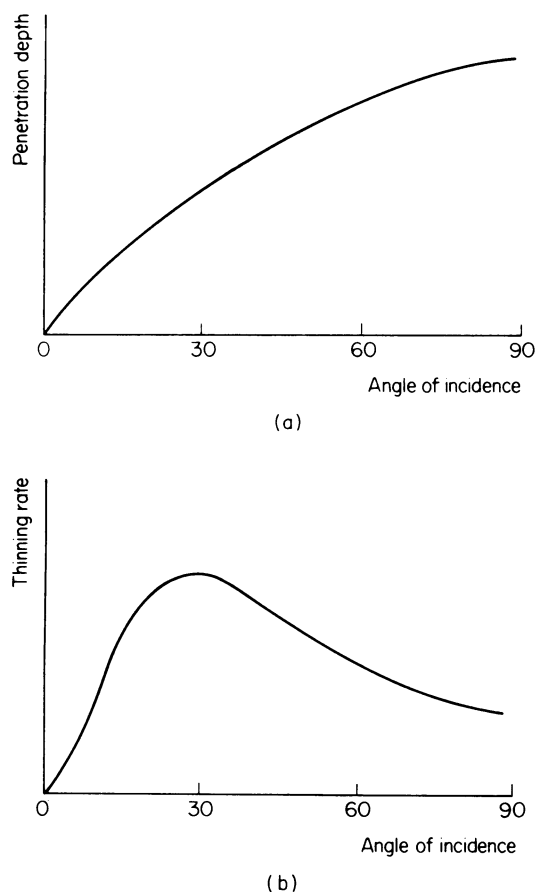


Figure 11 Schematic diagrams showing (a) the depth of penetration of argon ions as a function of the angle between the beam and specimen, and (b) the variation of thinning rate with angle of beam incidence

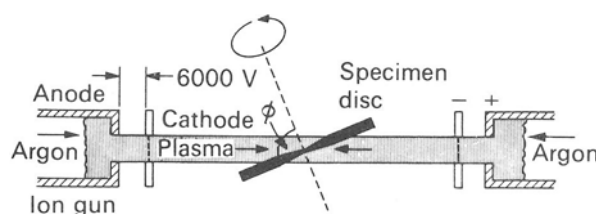


Figure 12 Schematic diagram of typical ion-beam thinning equipment

Figure 12 illustrates schematically the ion-beam thinning equipment. The specimen is rotated in a special holder such that two beams impinge on opposite sides of the specimen at low (5–30°) angles of incidence. The specimen may take the form of a disc or a sliver of material, but, because the rate of thinning is so slow, e.g. 0.5–0.15 μm/h, it is essential to begin with as thin a piece of material as possible. Consequently, discs may be ground as thin as possible, then dished chemically or using a ball-ended tool on a spark machine or an ultrasonic drill. Dishing is stopped just before the minimum specimen thickness at which damage appears in the electron-transparent areas. A similar approach may be used for slivers of brittle material such as SiC or Si₃N₄. These may be broken from the bulk, ground with emery to a sharp wedge shape, and the surface damage removed with ion-beam thinning. In the authors' experience, large areas are obtained by initial ion-beam machining at 90° to the specimen surface followed by final thinning at approx. 18° angle of incidence.

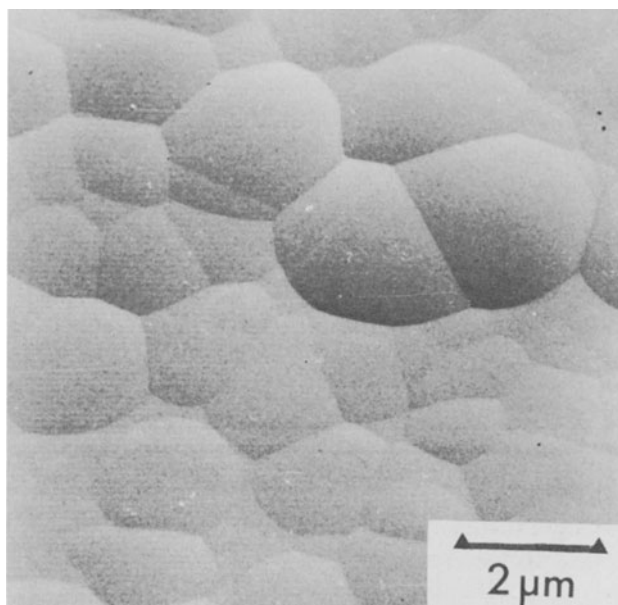
It is important to realise that, in two-phase material, progressive surface roughening may occur if glancing angles of incidence are used for long periods, because surface bumps create 'shadow regions' which the ion beam does not reach. Under some circumstances, if incident angles >30° are used during the early stages of thinning, a slightly uneven surface is produced which is illustrated in figure 13a. Although the specimen is electron transparent (figure 13b), detail is obscured by the thickness fringes produced by the uneven surface. A correctly thinned specimen is shown in figure 13c.

Other artefacts may occur as a result of specimen heating, ion damage and possible development of surface structure similar to that described above and unrelated to the actual microstructure, see Trillat (1964) and Barber (1970). Consequently considerable care must be taken in interpreting details of the microstructure in ion-beam prepared specimens.

A major advantage of the ion-beam technique is the localisation of thinning such that the deformation associated with microhardness indentations (Rowcliffe and Hill, 1974) or the structure of interfaces, e.g. solid state devices (Bach and Schroder,



(a)



(b)

1969; Booker, 1970) may be studied. Figure 14 shows a picture of the deformation associated with a microhardness indentation in a single crystal of silicon. Furthermore, the reproducibility of the rate of ion thinning enables the microstructure at specific depths to be studied. Finally, because the edge profile does not change after perforation, specimens may be repeatedly polished and porous ceramics may be satisfactorily thinned.



(c)

Figure 13 (a) Transmission electron micrograph of an unevenly thinned SiC single crystal; this effect is produced by a slightly higher than normal ion beam incident angle (approx. 40°). (b) Scanning electron micrograph of the same specimen. (c) Transmission electron micrograph of a correctly thinned SiC single crystal

2.4 Chemical Polishing

Chemical polishing is useful for non-conducting materials. It may be applied to both the window technique, e.g. Broadway (1970), and the disc technique, e.g. Booker and Stickler (1962), Keast and Wilson (1966), Sanders (1969) and Hepfer (1966).

2.5 Specialised Techniques

A number of specialised techniques have been developed for preparing specimens of either specific materials, e.g. glasses, polymers, etc. or specific forms, e.g. fine wire. References are included in the tables in section 9.1.

Glasses are commonly blown to form thin films or ground from bulk. Other methods have been reviewed by Bach (1970). Many polymers are available in powdered form or are brittle enough to be ground with a mortar and pestle. The powder can then be suspended in liquids such as xylene, ethanol or water. Ultrasonic vibrations can assist in dispersing the powder. Sometimes small single crystals can be produced in liquid suspension. In either case, a few drops of the suspension are then placed on a substrate-coated EM grid and the liquid is allowed to evaporate. To increase contrast, the specimen can then be shadowed with germanium, platinum,

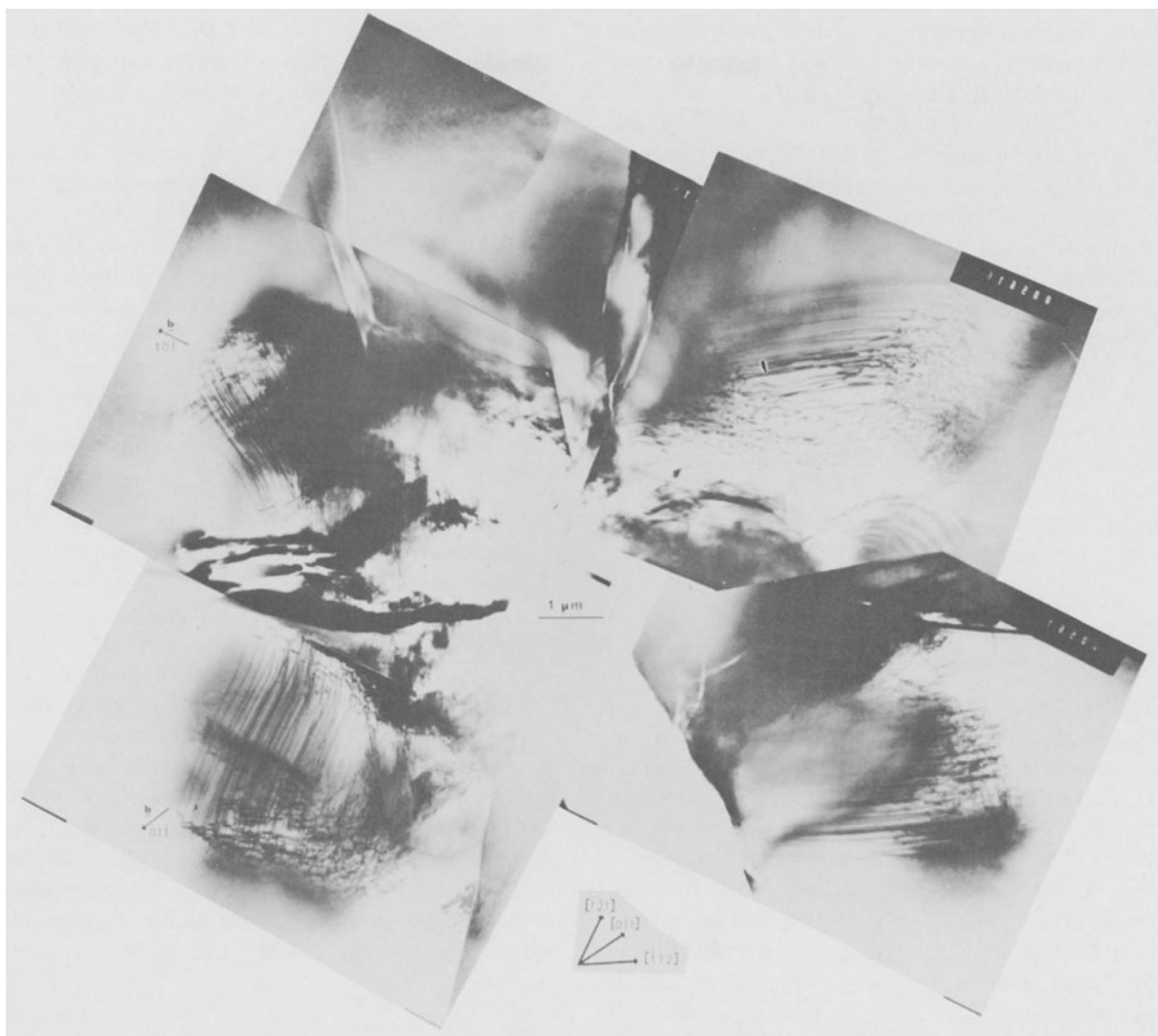


Figure 14 Montage showing the distribution of slip around a micro-hardness indentation in silicon (ion-beam thinned); the central portion is the position of the indenter (courtesy D. Rowcliffe)

platinum/carbon pellets, or a gold – palladium alloy. Electron diffraction patterns can be calibrated *in situ* with the aid of a thin evaporated layer of aluminium or gold.

Thin polymer films can be produced by floating a dilute solution of the polymer on water, and allowing the solvent to evaporate (the solvent being immiscible in water). The resulting film can be picked up on a 1cm square copper screen and specimens the size of mounting grids punched out. Similarly, a dilute solution of polymer can be allowed to evaporate from a cleaved mica surface and the resulting film floated off on water. After picking it up on a screen or grids, any residual solvent can be removed under vacuum.

Single crystals of a polymer can sometimes be produced by holding an amorphous film of the polymer at the crystallisation temperature. In other cases, a dilute solution of the polymer can be evaporated at the crystallisation temperature on

carbon-coated grids. If there is a possibility of the polymer agglomerating during slow evaporation of the solvent, the solution can be quickly frozen in liquid nitrogen and the solvent pumped off under a vacuum at a low temperature.

Use of an ultramicrotome for cutting thin slices of polymer materials has received considerable attention. It remains a powerful but difficult technique, in that each type of specimen is likely to require a different combination of embedding materials and cutting conditions. Sometimes the polymer must first be coated with a material to improve its adherence to the embedding material because the bond should have high shear strength (Ruznock and Hansen, 1965). The embedding material is not for support (as with biological materials) but it should provide a clean contact with the cutting knife. Temperature of both the specimen and knife can be varied to obtain satisfactory specimens. Martin (1969) notes that the specimen should be cut close to

its ductile–brittle temperature. At lower temperatures, fracture occurs in advance of the knife edge and at higher temperatures the specimen is too soft and deforms during cutting.

The staining of polymers often involves the selective deposition of heavy metal atoms*. Osmium tetroxide (OsO_4) selectively stains the diene portion of a diene-type elastomer. It also fixes (hardens) the elastomer, making it more amenable to ultramicrotoming. Selective stains have been used for other polymers: iodine vapour for polyethylene, bromine vapour plus ultraviolet light for polypropylene (Andrews, et al. 1967), chromic acid for bulk polypropylene (Armond and Atkinson, 1969) and phosphotungstic acid for nitric-acid-oxidised polypropylene (Hock, 1967).

Replication of fracture surfaces is perhaps the oldest method of studying the 'structure' of polymers. This technique is described in section 4.2.

2.6 Specimen Washing, Storage and Insertion into the Electron Microscope

The specimen is removed from the polishing solution with the voltage applied and gently agitated in a series of beakers of alcohol or distilled water. Usually three beakers, each containing a minimum of 100ml of chemical, are used and the voltage is switched off during washing in the first beaker. The first beaker is for general washing each time the progress of the polishing is checked. The second and third beakers are kept covered and only used for the final wash before a specimen is to be cut off and/or examined optically. This final wash consists of between 30 s and 3 min in each of the three beakers with continuous gentle vertical agitation of the specimen.

If the specimen has been painted with a protective lacquer, dissolving it with acetone will contaminate the specimen surface. It is best removed from thick regions of the specimen by painting another coat of lacquer on top and allowing this coat to dry slightly to soften the first coat underneath. Then both coats can be pulled off gently with sharp tweezers. This procedure leaves a clean surface and does not contaminate any other portion of the specimen, but is not recommended for thin areas because they are likely to be deformed. For removal of lacquer from thin areas use a solvent such as acetone before the very last polish which will remove any contamination from the lacquer dissolved in the acetone.

Some specimens can be stored in a vacuum desiccator and others in liquid such as ethyl alcohol. Specimens which cannot be stored because of oxidation, such as Mg, Fe, Ti and Cu, must be prepared

and used immediately. Often a specimen can be prepared up to the very last polish on one day, stored in the desiccator overnight, and given the final polish on the following day and then immediately observed.

An optical microscope should be used to mount the specimen on a grid and to align the top and bottom grids so that the maximum specimen area is available for observation. 50 or 75 mesh grids are usually best for thin foils, though 100 mesh grids may be used to reduce specimen drift. Special grids may be required for specimen heating, cooling and other special treatments in the microscope.

2.7 Selection of Specimen Preparation Technique

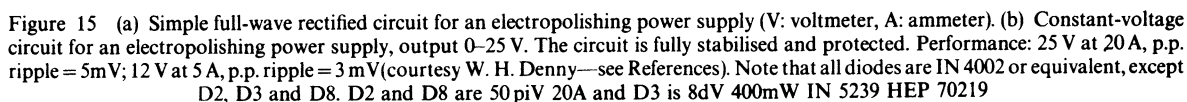
The best results are generally obtained with the simplest methods. Frequently greater total thin area is obtained with the window method rather than the disc method for a given time spent in preparation. However the disc method is economical on material and is essential for brittle materials due to the overall robustness of the specimen. Disc methods are unsuitable for ferromagnetic materials, particularly if the microscope has an immersion objective lens. Because of the relatively large magnetic field of the specimen the electron beam is deflected from the optic axis and resolution is seriously degraded because of the astigmatism in the image. This can only be satisfactorily compensated for in small window-type specimens which, for a given material, have a lower magnetic field because of their reduced volume.

2.8 Power Supplies for Electropolishing

The d.c. supply required for electropolishing may be produced from a battery if a low voltage is required, but this is unsatisfactory because current surges occur when the specimen is immersed in the polishing solution which destroy the polishing conditions. Consequently, thin foils cannot be repolished. It is better to use a variable transformer and rectifier in the circuit shown in figure 15a, but a constant voltage supply with reduced ripple on output is even better because of the improvement in specimens obtained at modest increase in cost of the unit. A typical circuit is shown in figure 15b.

As explained in section 2.1, a potentiostat is useful for determining polishing conditions. However, electropolishing under potentiostatically controlled conditions is only justified when the material is particularly difficult, or large very thin areas are required, e.g. high-atomic-number materials. In general it is wrong to economise on polishing equipment because of the overall time wasted either in

* Andrews (1964) used osmium tetroxide vapour to stain sections of unsaturated hydrocarbons (natural and synthetic elastomers). The vapour diffused into and stained the amorphous regions, but was excluded from the crystalline regions.



particles and water. Furthermore the electrolyte should be protected from contamination by the coolant during the initial effervescence during the first stages of cooling.

2.9 Cooling Baths

Table 1 Temperatures obtainable with various common cooling solutions—coolant solid CO₂ (0 to -78°C) or liquid N (0 to -197°C)

<i>Liquid</i>	<i>Temperature (°C)</i>	<i>Liquid</i>	<i>Temperature (°C)</i>
Glycerine	− 8.3	Chloroform	− 63.5
Castor oil	− 9.94	Acetone	− 94.1
Ethylene glycol	− 13.0	Toluene	− 95
Carbon tetra- chloride	− 22.8	Methyl alcohol	− 97.6
Dodecane	− 25.96	Carbon disulphide	− 111
Decane	− 29.6	Ethyl alcohol	− 114
Turpentine	− 59.4	Ether	− 116
		Propyl alcohol	− 127

Table 2 Temperatures obtainable with various common cooling mixtures based on weight % additions to water

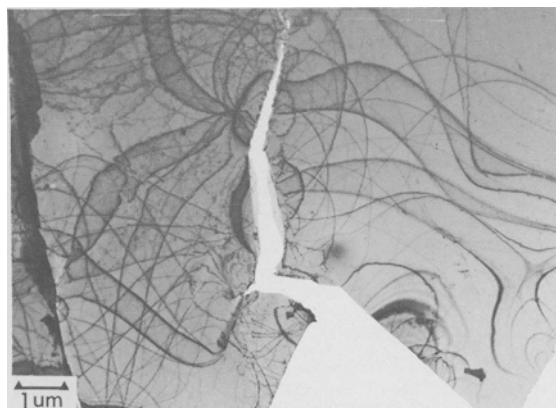
Addition	Temperature (°C) for given weight percentage addition				
	10%	20%	30%	40%	50%
Methyl alcohol	-6.5	-15.05	-25.2	—	—
Ethyl alcohol	-4.5	-10.9	-20.1	—	—
Ethylene glycol	-4.4	-9.4	-15.5	-24.4	-35.5
Calcium chloride	-5.5	-18.4	-44.4	—	—

Adequate safety precautions are necessary when using low-temperature baths. Skin burns may occur, and toxic, skin-irritant or explosion hazards may be present, particularly during initial cooling of the bath when the evolution of gas is usually very rapid. Adequate venting and room ventilation are essential.

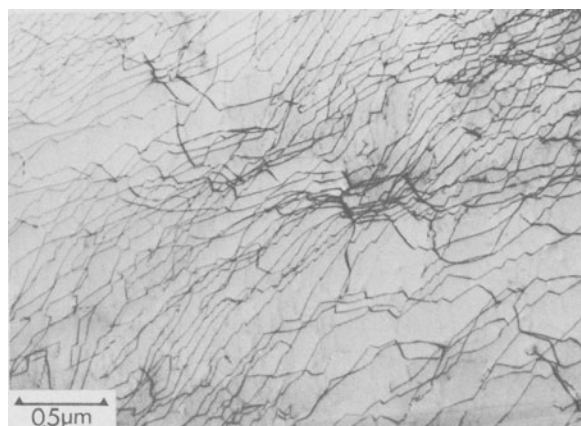
3 ARTEFACTS IN THIN FOILS

There are a number of artefacts that may arise from mishandling the specimen, careless specimen preparation, etc. Usually these can be avoided relatively easily by sensible precautions. Some common artefacts are discussed below.

1. Careless handling. A large number of bend contours of the type shown in figure 16a may be produced. However, if heavy damage is incurred, long dislocations of the type shown in figure 16b occur in thicker regions, while the specimen may crack or tear at the edge, as shown in figure 16a.
2. Careless washing. Surface deposits are produced (figures 16c and d) despite the fact that the specimen may be optically bright and clean.
3. Contamination with hydrogen during electropolishing. This is particularly common with transition metals such as Ti, Zr, etc. Typical effects are shown in figures 17a and b.
4. Contamination with interstitials during polishing, or after prolonged storage at room temperature. This is common in b.c.c. transition metals such as Nb and Ta (Van Torne



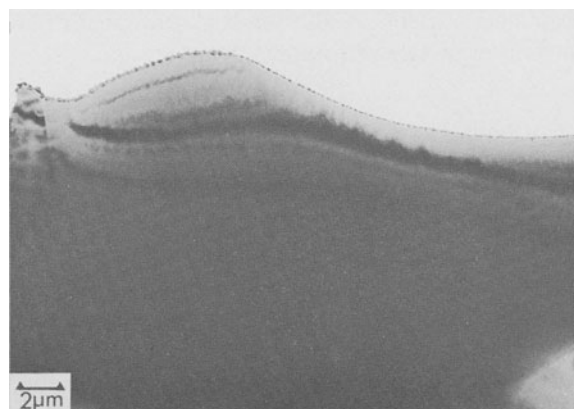
(a)



(b)

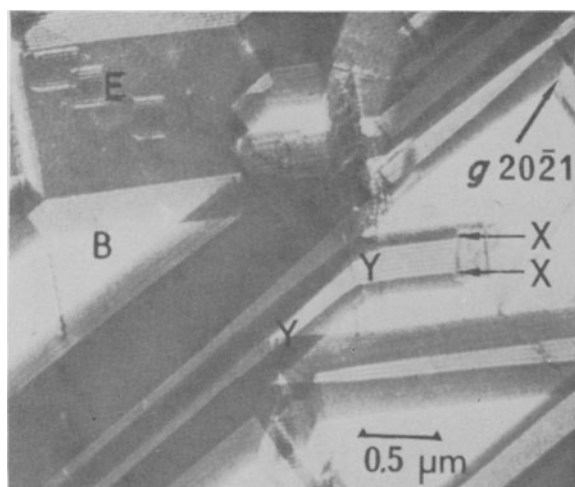


(c)

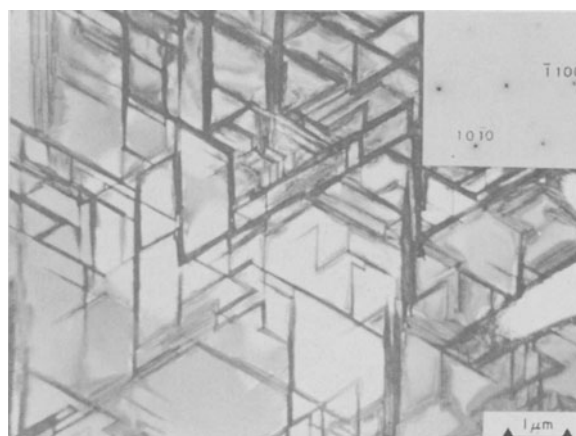


(d)

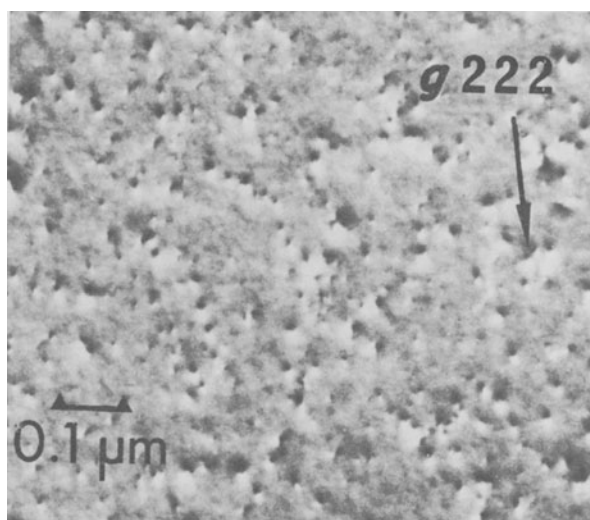
Figure 16 (a) Tear in a metal foil with associated bend contours, (b) dislocations introduced by mishandling the thin foil, (c) a contaminated foil, i.e. incorrectly washed and (d) talcum-powder particles adhering to the edge of a thin foil



(a)



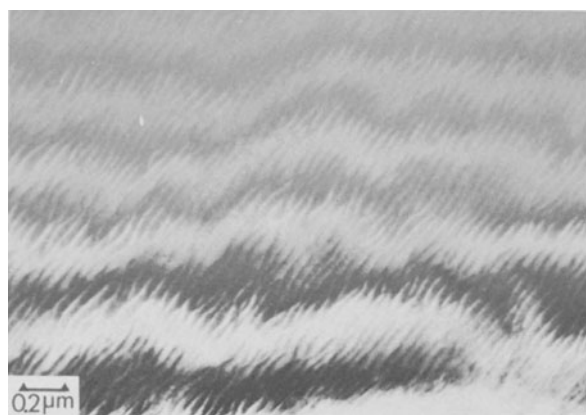
(b)



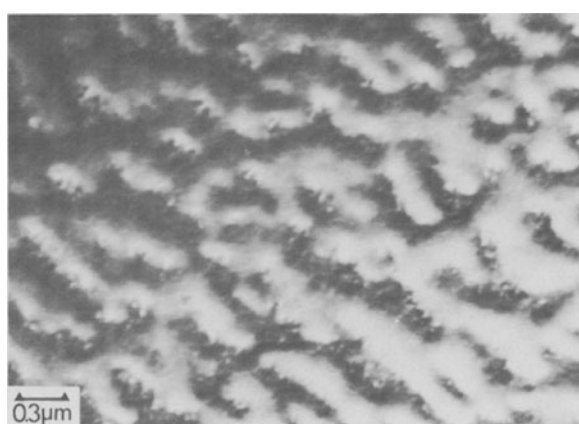
(c)



(d)



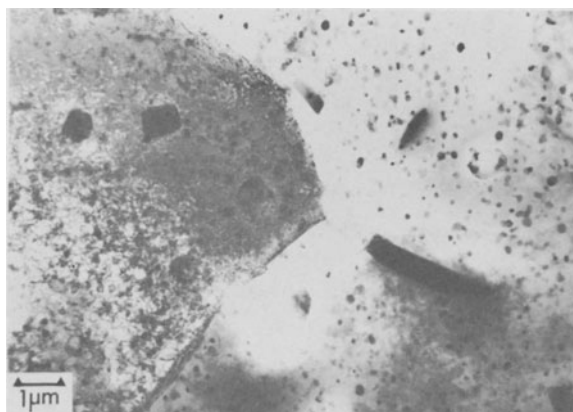
(e)



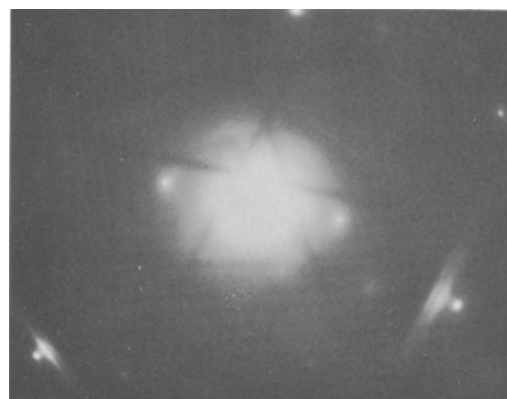
(f)

Figure 17 (a) Boundaries, e.g. XY, produced by ordering of impurity, probably hydrogen introduced during electropolishing in a Ti-24at.%Sn alloy. (b) Hydride introduced into a Ti-8wt.%Al-1wt.%Mo-1wt.%V alloy during electropolishing (courtesy J. D. Boyd). (c) Ion damage in nickel; small Frank loops on {111} are created and produce the black/white lobe contrast. (d) Etch pits in an aluminium foil. (e) Rippled surface produced by streaming of the electropolishing layer because of insufficient stirring of the polishing solution. (f) Ion-beam thinning damage in an aluminium foil

- and Thomas, 1964; Villagrana and Thomas, 1965). The effect is similar to figure 17a.
5. Some materials oxidise rapidly, even during observation in the microscope, to produce stacking faults, etc., e.g. Mg, Zn (Dobson and Smallman, 1966).
 6. Ion damage may occur in the microscope, to produce the effect in figure 17c.
 7. Slight etching or surface mottling may arise during electropolishing (figures 17d and e).
 8. Ion damage may occur during ion thinning (figure 17f).
 9. During polishing of two-phase material, particles that have been polished-out may re-deposit on the surface of the foil (figure 18a).
 10. Oxide on the specimen surface may produce split Kikuchi lines in diffraction patterns, and Moiré patterns in images of thin foils of aluminium (figures 18b and c).
 11. Oxide may produce surface mottling (figure 18d).
 12. Oxide on the surface of steel specimens can often complicate the interpretation of images and diffraction patterns (Keown and Dyson, 1966; Abrams, 1970).
 13. Streaks can arise in diffraction patterns because of surface films produced during electropolishing, e.g. gold films on gold-nickel alloys (Woodilla and Averbach, 1968).
 14. Epitaxial layers of intermetallic compounds may form during electropolishing. Thus Jubb and Laufer (1971) report the formation of AlNi or Al₃Ni fibres in a composite with an aluminium matrix.
 15. Martensite may form spontaneously in thin areas of the foil, even above the martensite transformation temperature (Hull, 1962; Blackburn and Williams, 1967; Georgieva et al., 1970). This effect is particularly common in titanium, zirconium and iron-based alloys.
 16. Veining occurs in Ni-10%Ti alloys during electropolishing (Ardell, 1969).
 17. Dislocation rearrangement and loss can occur in thin regions of the specimen if the lattice friction stress for dislocations is low, e.g. pure metals with f.c.c. or c.p.h. crystal

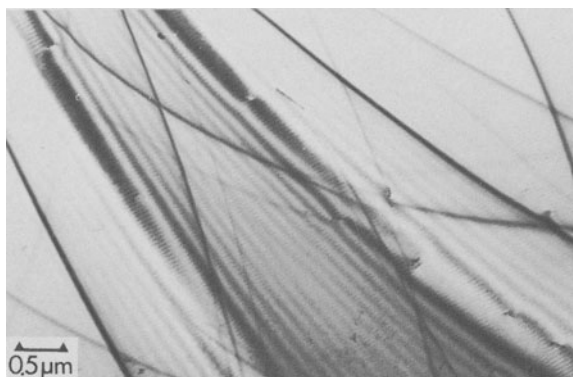


(a)

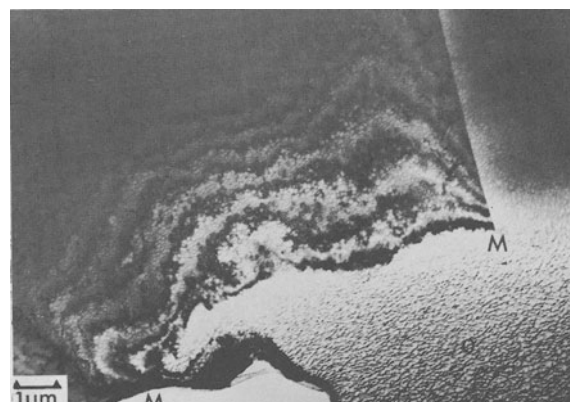


(b)

A



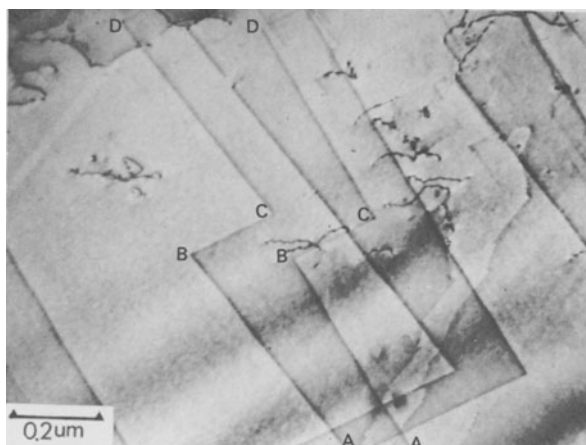
(c)



(d)

B

Figure 18 (a) θ' precipitates deposited on the surface of an aged Al-4wt. %Cu alloy during electropolishing. (b) Paired Kikuchi lines produced on an Al-10.7 at. % Li foil in (c), which is a bright-field image with Moiré pattern lines in the direction AB. (d) An Al-4wt. % Cu alloy oxidised during electropolishing; O is the oxide film only and MM is the edge of the metal/oxide sandwich. (e) Series of slip traces (e.g. ABCD) produced by motion of dislocations moving under stresses generated by carbon contamination. This was not enclosed in an aluminium foil



(e)

Figure 18 (continued)

structures. However this may be reduced if anodic oxidation preparation techniques are used.

18. Carbon contamination can produce stresses that cause dislocation movement and the formation of slip traces (figure 18e). Each pair of lines corresponds to the intersection of the induced slip plane with the top and bottom surface of the thin foil.
19. Preferential nucleation of precipitates on foil

surfaces frequently occurs during use of heating stages (Thomas and Whelan, 1961).

20. Deformation twinning can occur in bent thin foils, e.g. Cu, even though it does not in the bulk material (Ahlers and Vassamillet, 1968).
21. Dislocations generated in thin foils frequently dissociate to form visible stacking faults because of local stresses, whereas dissociation of dislocations produced by bulk deformation is not observed.
22. Metastable b.c.c. Ti alloys can spontaneously transform during thinning to produce planar features, and sometimes relaxation of martensite (Spurling et al., 1974).
23. Al-Cu and Al-Ag alloys can develop surface films rich in Cu or Ag during electropolishing (Nicholson et al., 1958; Thomas, 1961). These workers showed that the Cu and Ag may be removed by washing in 50% nitric acid in water and the Cu may be removed by washing in chromic acid (Kelly and Nutting, 1959).

Clearly, care should be taken in perfecting a reproducible thinning technique that does not introduce artefacts, and for some difficult and reactive materials comparison of microstructures after different processes of thinning may be necessary, e.g. Spurling et al. (1974). In addition, care must be taken in interpreting some aspects of the microstructure likely to be affected by the proximity of the surface, or the removal of bulk constraints, on the structure.

4 REPLICAS

Scanning electron microscopy has replaced replicas for surface studies except in the following three cases:

1. Where higher resolution (better than 100Å) is required.
2. Where the specimen is destroyed by the electron beam (e.g. polymers).
3. Where extraction of particles for identification is necessary.

These cases are dealt with below. Additional details may be found in Bradley (1956, 1965) and Goodhew (1973).

4.1 High-Resolution Replicas of Metals/Alloys

The Replica

Replicas are used for detailed quantitative surface studies, e.g. detection and measurement of slip lines 20–100Å high on the surface of specimens. Either carbon or a carbon–platinum mixture is deposited

on the specimen surface *in vacuo* using a d.c. arc source. Generally a commercially available vacuum evaporator is used, evacuated to a pressure of 10^{-4} mm of Hg. The specimen is placed such that it is in line of sight with, and approximately 5–20 cm from, the arc as shown schematically in figure 19. The thickness of carbon deposited is usually 100–200Å, judged from experience by observation

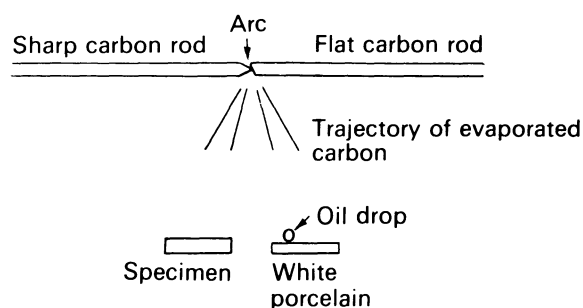


Figure 19 Schematic diagram illustrating the essential features of vacuum evaporation of carbon

of a piece of white porcelain placed near the specimen and having a drop of diffusion-pump oil on it. As coating proceeds the porcelain becomes darker, but that under the oil drop remains white.

Removal of the replica from the surface of a metal specimen usually involves etching the specimen to free the porous carbon film, followed by floating off the replica on the surface of distilled water (figure 20). If the surfaces of the specimen and replica are scored with a sharp needle in a grid pattern, the replica breaks up on the surface of the water and portions may be picked up on grids, dried on filter paper and stored for use. Chemical etching is usually employed, but electrolytic etching using conditions in the portion AB of figure 5a may be used. As an alternative to etching, e.g. when the surface must be preserved, an outer plastic Formvar film may be used to assist in stripping. A thin-release film may also be used to coat the surface of the specimen before the carbon is laid down (Bridges and Long, 1958) but resolution is lost with this method.

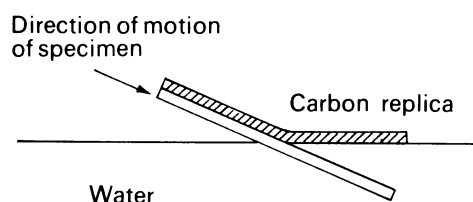


Figure 20 Floating off a carbon film on the surface of distilled water

As an alternative to carbon films, oxide films produced by anodising techniques are occasionally used. These may usually be stripped from metals by a 2–10% solution of iodine or bromine in alcohol over a period of hours or days.

The above techniques are satisfactory for studies of reasonably smooth surfaces, but rough surfaces, e.g. fractures, require two-stage carbon replicas because single-stage carbon replicas cannot be easily removed. The two-stage process involves some loss of resolution, but in many cases is still better than the scanning electron microscope. The process is illustrated schematically in figure 21. In the first stage the surface of the specimen is thoroughly wetted with acetone and a piece of cellulose acetate film (e.g. Bexfilm) is pressed gently against the surface. The film dries in 10 min and can be peeled off with tweezers or stripped using adhesive tape. The surface of the plastic replica that was in contact with the specimen is then coated with 100–200Å of carbon as described above. The replica may then be shadowed, the plastic dissolved in chloroform, and the remaining carbon replicas washed with water, dried, then viewed in the electron microscope.

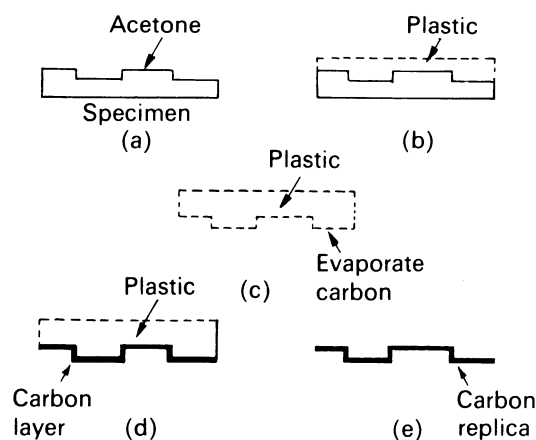


Figure 21 Sequence of operations in the production of a two-stage carbon replica

Often fracture chips may be stripped from a fracture surface and can be transparent to electrons (Stevens, 1970 and 1971) thus enabling dislocation structures to be studied.

Shadowing

There is not much contrast in images of carbon replicas because there is little change in thickness from point to point. Contrast is improved by shadowing with a heavy metal such as platinum, silver or gold. The element is evaporated *in vacuo* at a low angle to the replica surface, from a piece of wire hung on a tungsten filament producing shadow effects (figure 22). Selection of the angle of shadowing is based on the height of the surface features, larger angles being used for rough surfaces. To provide a local measure of the shadowing angle, latex balls of known diameter may be distributed on the replica surface before shadowing (figure 23b). The height of slip steps, etc. may then be easily measured by comparison with the size of the latex ball shadow.

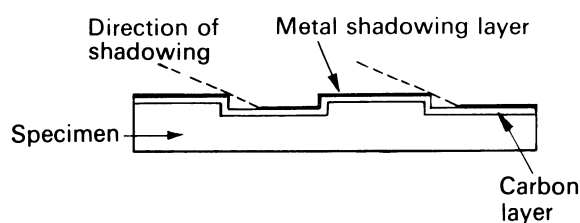
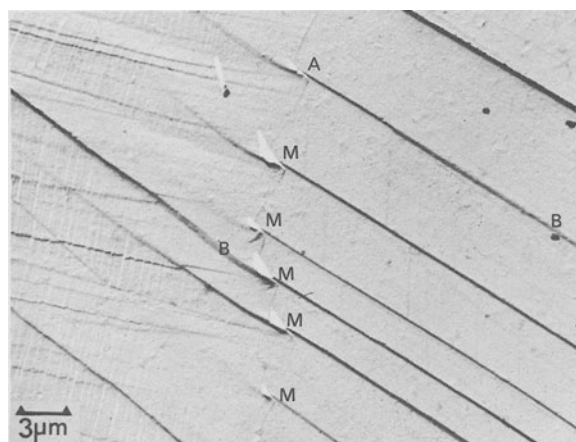


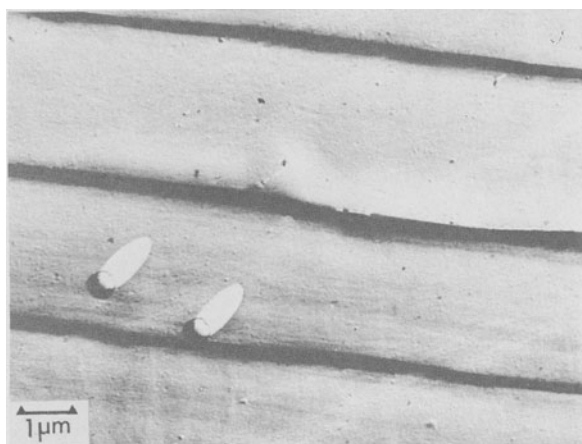
Figure 22 Shadowing of a carbon replica

Replicas From Specific Areas

Techniques for this process have been given by



(a)



(b)

Figure 23 Shadowed carbon replicas showing (a) grain-boundary microcracks M and offsets in a Ti-8wt.%Al alloy near the final fracture (AB are slip traces) and (b) slip bands in polycrystalline iron deformed 20% in compression at 20°C (note white shadows from latex balls). From Rosenfield and Hahn (1970), courtesy *Met. Trans.*

Savanick (1967). The area of interest is located optically and a specimen grid with distinctive grid squares is placed upon it. A drop of 10% nitrocellulose dissolved in amyl acetate is placed next to the grid so that it spreads over it without moving it. The grid and attached replica may be removed as above after drying, the contact surface coated with carbon and observed in the usual way after dissolving the plastic.

Holey Carbon Replicas

These replicas are commonly used for astigmatism correction by observation of the Fresnel fringe at a small hole. Several preparation techniques have been suggested, e.g. Harris (1962), Fukami and

Adachi (1965), and Johnston and Reid (1971). The technique due to Harris (1962) is easy to use and is described below. An emulsion of glycerol in 0.25% Formvar solution is used. A cold (0°C) glass microscope slide is dipped in the solution, allowed to dry and the Formvar replica floated off onto distilled water. This film contains a hole corresponding to each droplet of glycerol. It is scooped up on a large coarse screen with several support grids (200 mesh) on it. After drying, an approx. 100Å thick carbon film is evaporated onto the film *in vacuo*. The Formvar is dissolved away in chloroform and the grids then support a holey carbon film suitable for observation in the microscope.

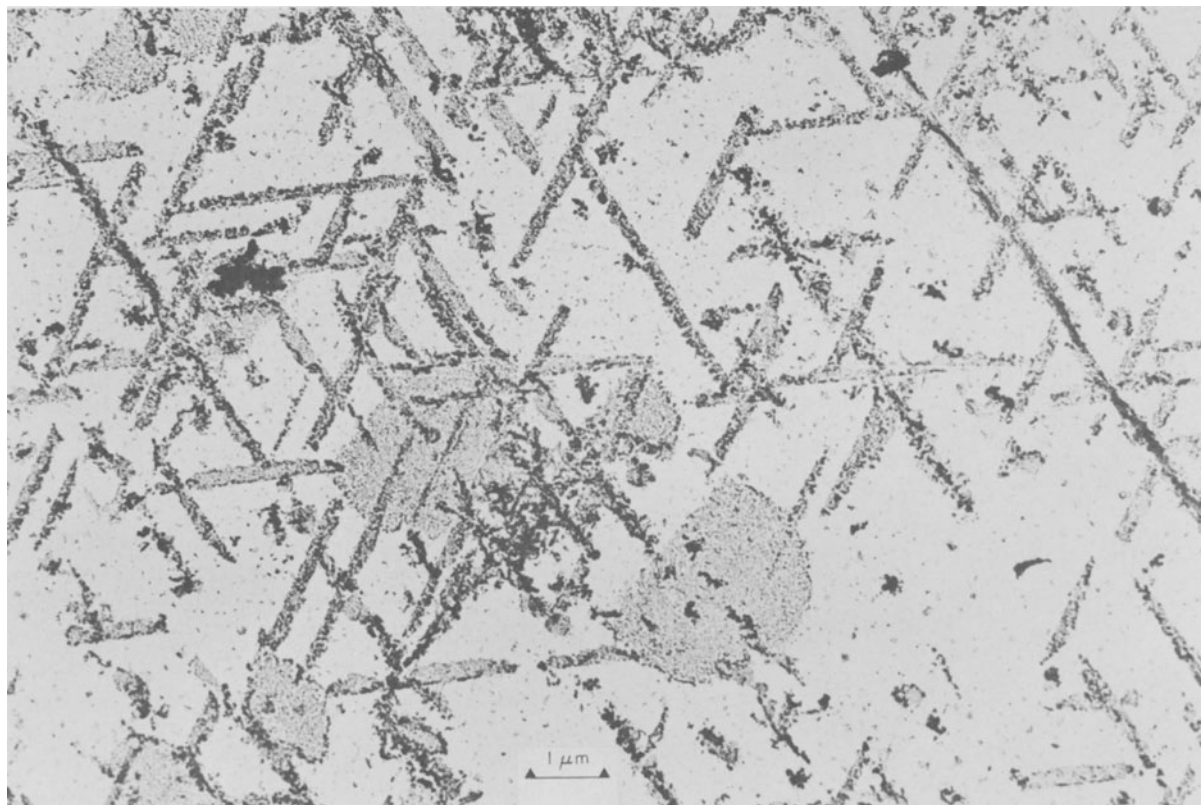
4.2 Replication of Polymers

Normally a fracture surface is produced at liquid nitrogen temperatures and then replicated with one- or two-stage techniques. The replica may be stripped from polyethylene by boiling xylene vapour (Sakaoku and Peterlin, 1967). Alternatively, carbon replicas may be stripped from polyethylene and polytetrafluorethylene by depositing a layer of polyacrylic acid (PAA) from a 5% solution in water, drying, followed by dry stripping. After mounting on a specimen grid the PAA is washed off in water (Peterlin and Sakaoku, 1967; O'Leary and Geil, 1967). Where necessary shadowing techniques are employed. Techniques for polymers are summarised in section 9.3. Note that gelatin or cellulose acetate is sometimes used as first-stage replicas.

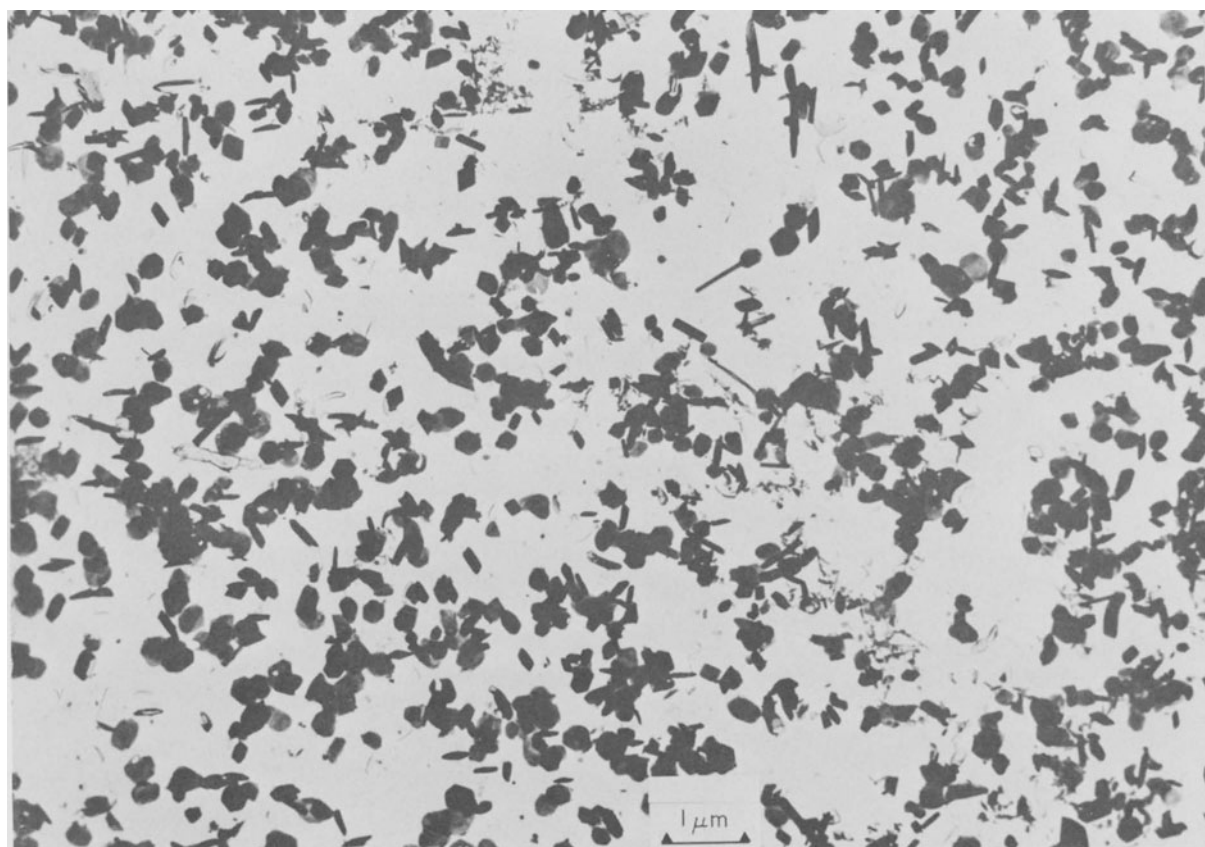
If the polymer contains any structural supermolecular formations, then the boundaries between them should be the weakest places through which the crack should run during fracture. Consequently, the supermolecular structure is revealed in the replica. If not, it may be necessary to attempt to etch with poor solvents (analogous to metals). However, this technique must be applied with care to polymers because solution of the surface layers is often preceded by swelling to a considerable depth (Marikkin et al., 1971). Ion bombardment (which can produce surface melting) and etching in active oxygen are also used (Bezruk et al., 1968). In all cases, experiments must be carefully controlled and the results of several preparative methods compared to recognise artefacts.

4.3 Extraction Replicas

This technique finds frequent application for identifying or counting precipitates in metallic, ceramic or glass systems. Typical extraction replicas are shown in figures 24a and b. Furthermore it has been used successfully to study fibrils of polyethylene and p.t.f.e. (Peterlin and Sakaoku, 1967; O'Leary and Geil, 1967). The process is illustrated schematically



(a)



(b)

Figure 24 Extraction replicas from austenitic stainless steel containing 18wt.%Cr, 12wt.%Ni, 1.23wt.%Nb, 0.09wt.%N aged for (a) 200 h (NbN_2 stacking fault precipitate) and (b) 800 h (laves phase) at 700°C (courtesy D. W. Borland)

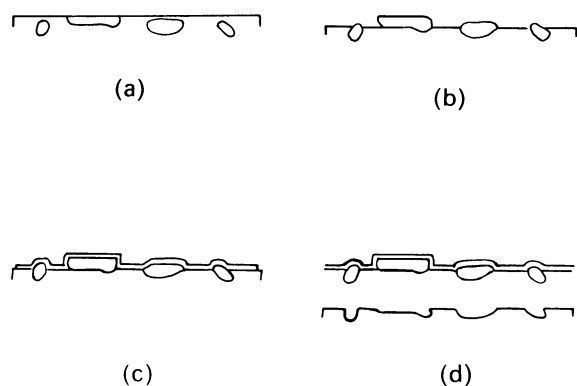


Figure 25 Sequence of operations in the production of an extraction replica

for metals in figure 25. The specimen is first etched to expose the particles, then a single-stage carbon replica is prepared as described previously, the second etching stage removing the particles with the

replica. Subsequent shadowing may be necessary to determine the three-dimensional shape of the particles, but is not used if the particles are to be studied using selected area diffraction, or microanalysis is to be performed using X-ray fluorescence.

The second etching stage is speeded up if the replica is scratched in a grid. Nital is a suitable etch for steels, and 10% bromine in methanol for most other materials. It is most important to realise that particle shape is likely to be modified by etching (Karchner and Stephenson, 1967), and that if several, chemically different particle types are present, one or more may be dissolved completely by the etch. Furthermore, strongly oxidising etches may introduce spurious oxide particles into the replica (Habrovec, 1968) and composition changes may occur in particles during replication. For all these reasons comparison of the results of two etches is often useful for multiphase microstructures.

Section 9.4 contains various extraction replica methods for metals.

5 PREPARATION OF HIGH-RESOLUTION TEST SPECIMENS

Conventionally, three types of specimen are used as high-resolution test specimens:

1. Single-crystal gold films with (100) foil plane.
2. Partially graphitised carbon black.
3. Shadowed replicas for point to point resolution.

The preparation techniques are described below.

5.1 Single-Crystal (100) Gold Films

Single-crystal gold films have been shown to produce crossed fringe images (Komoda, 1966) with spacing 2.04 and 1.44Å (figure 26a). In general these test specimens must be very thin (30–40Å) with a low defect density. To achieve such a thin film it is essential to vacuum evaporate the material. The sequence of events involves evaporation of an intermediate layer of silver, approx. 1000Å thick, onto a freshly cleaved {100} rocksalt substrate held at 450°C (Bruck, 1936; Shirai, 1943; and Bassett, 1965). This is followed by evaporation of a thin layer (30–40Å) of gold onto the silver at the same temperature. The combined silver–gold film may be floated off in distilled water, transferred to 50% nitric acid to dissolve the silver, washed in distilled water and mounted on a 200 mesh grid. These films are not in general completely continuous and a few polycrystalline regions may occur.

Direct evaporation of gold onto rocksalt at 450°C is not recommended because the films tend to be much thicker to maintain continuity.

5.2 Partially Graphitised Carbon Black

This test specimen was first suggested by Heidenreich, Hess and Ban (1968) who also describe its preparation. A picture is shown in figure 26c. Standard carbon black is used (U.S. designation I.S.A.F., ASTM-N-220) which consists of small particles approx. 250Å in diameter primarily used to impart high abrasion resistance to tyre treads. This powder may be partially graphitised by heating at 2600–3000°C for 30 min under argon in a graphite crucible. The carbon black may then be dusted directly onto a holey carbon support film. Alternatively it may be dispersed ultrasonically in chloroform then transferred to the support film by dipping.

5.3 Replicas for Point to Point Resolution Tests

These test specimens consist of a thin carbon film shadowed with platinum. The preparation procedure described here is that due to Nauta and Van Wijngaarden (1964). The form of the specimen on its support grid is shown in figure 27. Several methods have been suggested to produce the support film, and the most successful is as follows:

Prepare 6ml of 0.25% Formvar in chloroform and 0.05ml of 25% Teepol in distilled water. Mix to form a milky stock solution. Add 0.35ml of this stock to 10ml of 0.25% Formvar in chloroform, then dip a clean glass slide into the solution. When the film is dry it is floated off on distilled water and mounted

on grids. For this stage, lay a number of support grids on a coarse mesh gauze and use the gauze to scoop up the Formvar film. Dry on a filter paper and pick off the grids with tweezers.

Holes in the Formvar film may now be produced by placing the support grids in a dish filled with 20–25% amyl acetate in benzene. After 15–30min the grids are removed and dried on a filter paper. As with other films, the speed with which the glass is withdrawn from the solution influences the nature of the film. Fast withdrawal results in a thick film, slow withdrawal in a thin one. With a thick film, larger holes result and such a film is subsequently suitable as a basis for supporting a thinner film or delicate specimens (the so-called 'micro-grid'). In a

thin film, smaller holes result and this is suitable for astigmatism correction.

The size of the holes is, however, also influenced by the time of immersion in the amyl acetate/benzene bath, the longer times producing, in general, larger holes.

The holey film is then covered with evaporated carbon and then gold to build up the support grid for the final high-resolution film. The thin carbon film is evaporated onto a piece of freshly cleaved mica, the thinner the film the better, then stripped onto water and collected on the prepared grids as for the holey Formvar film already mentioned. Allow to dry.

The final step is to evaporate a little platinum or

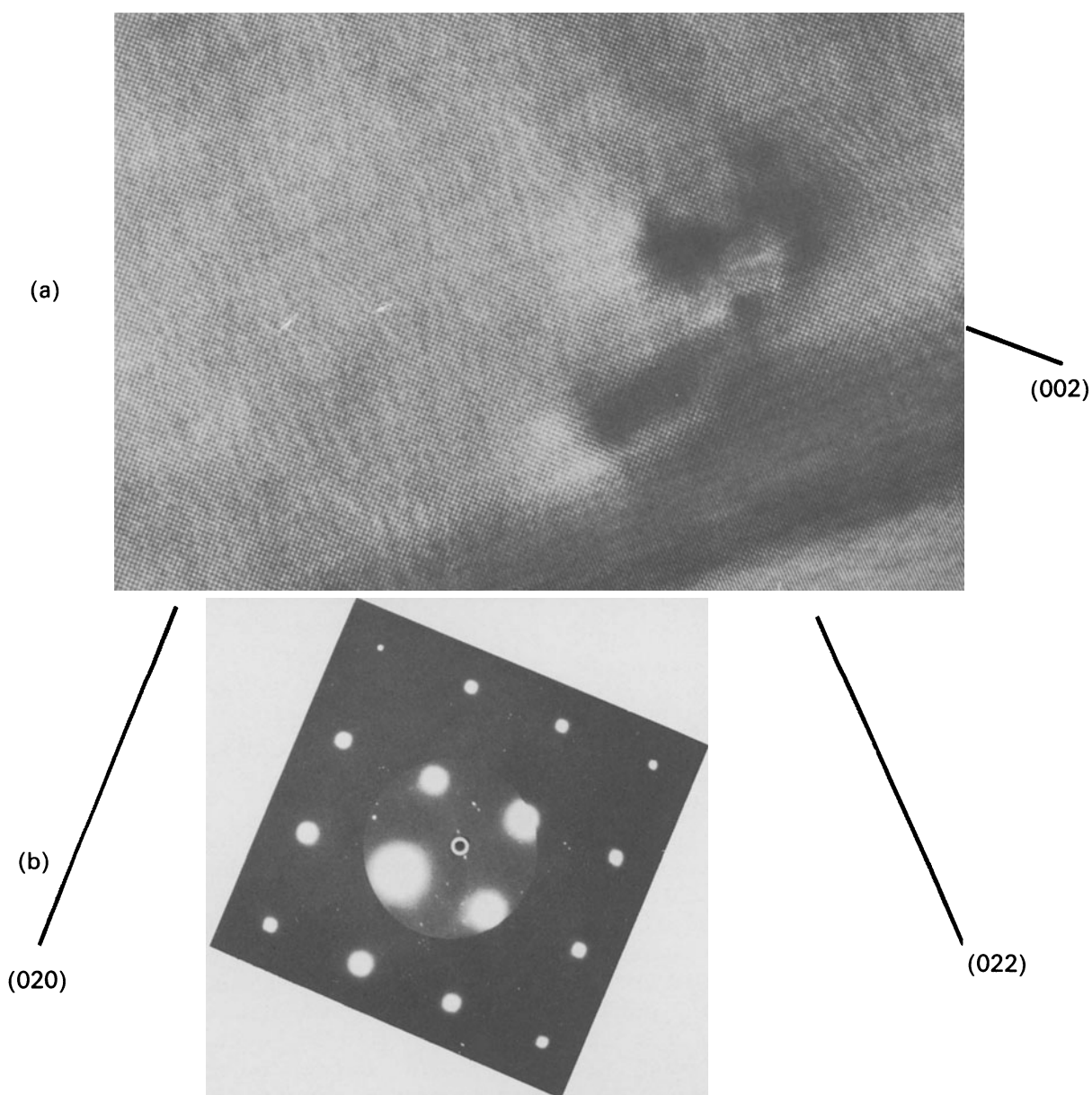
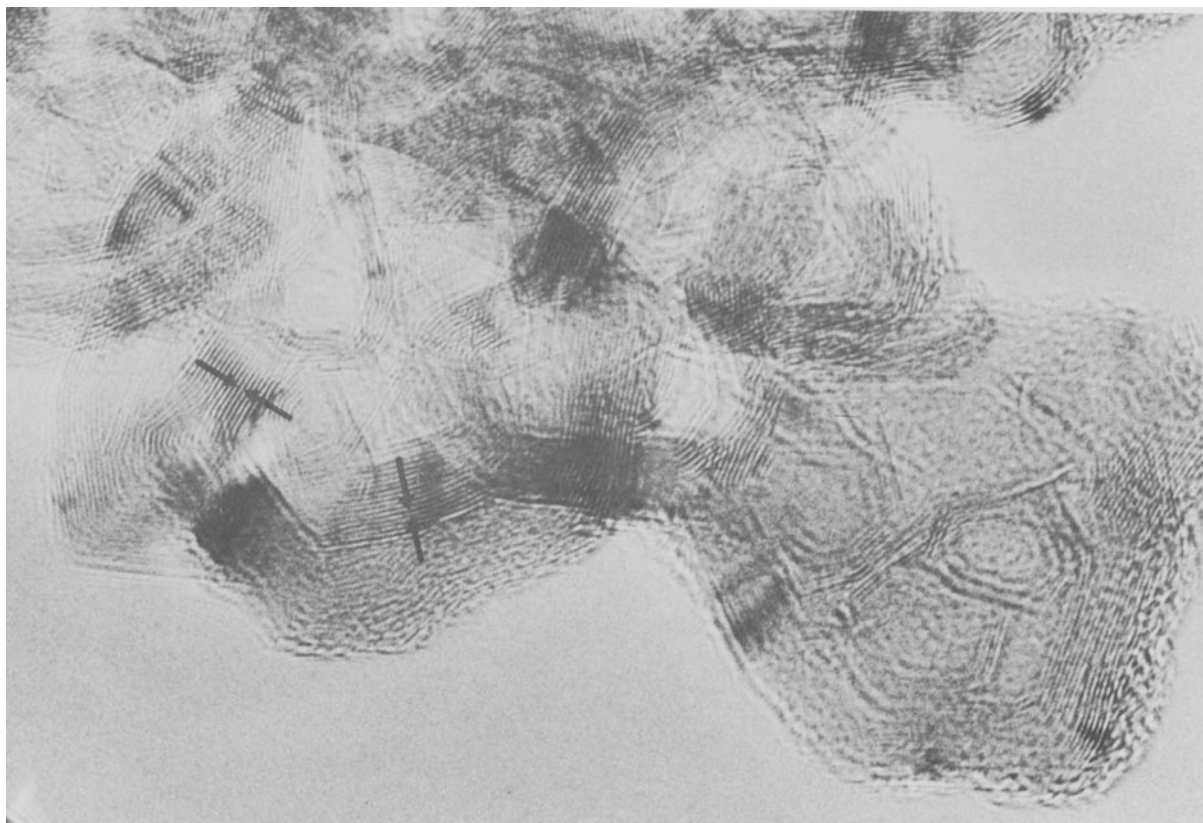
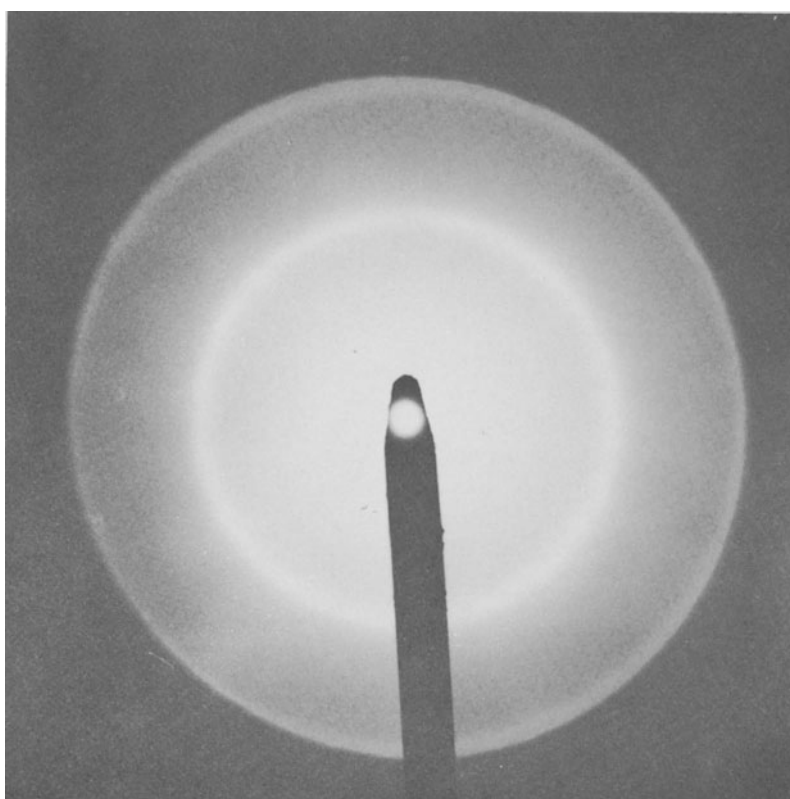


Figure 26 Electron micrograph of crossed fringes corresponding to (200) and (220) in an [001] gold film, (b) SADP showing the position of the objective aperture and optic axis, (c) fringe image in partially graphitised carbon black and (d) SADP showing the position of the objective aperture (courtesy F. Sheldon)



(c)



(d)

Figure 26 (*continued*)

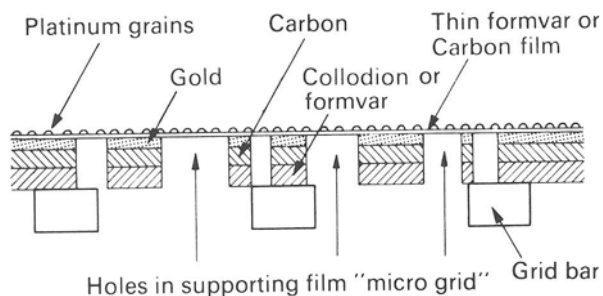
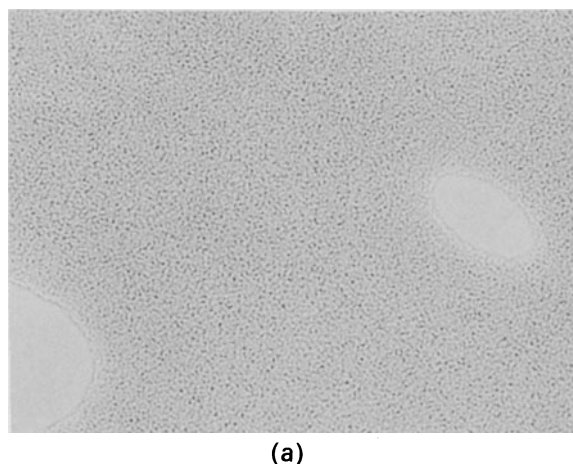


Figure 27 Construction of a replica for point to point resolution tests (courtesy R. Nauta and J. D. Van Wijngaarden)



other heavy metal onto the film. The platinum islands themselves may be used to check resolution above 10Å but the structure of the support film itself is more suitable below this value.

Figure 28a shows a typical example of an image from a high-resolution replica. The resolution is best checked by optical diffractometry (Thon, 1971; see figure 28b).

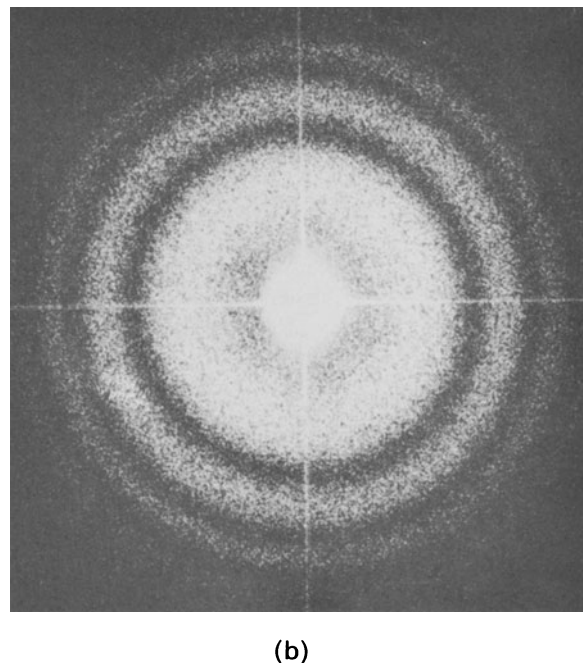


Figure 28 (a) Typical image of a high-resolution carbon replica showing minimum point-to-point resolution of 5Å and (b) corresponding light optical diffraction pattern; the inner ring is the 5Å spacing (courtesy P.N.T. Unwin)

6 SAFETY

It is essential for research workers to acquaint themselves with the properties of all chemicals that they use, and to know remedial first aid for likely accidents. When using or mixing polishing solutions it is essential to wear protective rubber gloves. Either a plastic face guard should be employed or the solution should be used in a fume cupboard with the front door closed to give protection. Additional precautions should be taken for the specific solutions mentioned below. If in doubt consult *The Handbook of Laboratory Safety*, edited by N. V. Steere and published by The Chemical Rubber Co. (1967, 1971) and *Dangerous Properties of Industrial Materials*, edited by N. I. Sax and published by Van Nostrand Reinhold Co. (1968).

6.1 Cyanides

Cyanides are highly toxic and should always be avoided in preparing electron microscope specimens. If an alternative solution is available, use it.

The following rules must be obeyed when using cyanides.

1. Confine work to a fume cupboard that is only used for cyanides, and always wear rubber gloves.
2. *Never* pour cyanides down drains and *never* bring acid into contact with them or near them.
3. *Never* pipette a cyanide solution by mouth or allow cyanide to come in contact with the skin. The danger of the latter is often underestimated.
4. *Never* leave cyanides about in the laboratory after use.
5. After using cyanides, work space and sinks should be washed well with an alkali solution, followed by water.

6.2 Hydrogen Fluoride

HF burns are extremely dangerous. Consequently

complete protection of exposed parts of the anatomy is essential. Use rubber gloves without pinholes, and plastic visors.

First-aid treatment for HF burns is as follows.

1. Wash the burnt part under the cold tap for one full minute.
2. Rub, with the finger, the affected part with 3 % calcium gluconate jelly for 10 min.
3. Report to hospital immediately.
4. The jelly should be kept and used solely for HF burns.

6.3 Hazards in Electropolishing

Perchloric Acid Solutions

Electropolishing solutions containing perchloric acid have been the cause of fatal explosions and great care is necessary when preparing and using solutions containing this reagent. The ranges of compositions which give rise to both explosive and inflammable mixtures for the ternary system perchloric acid–acetic anhydride–water are shown on the phase diagram in figure 29.

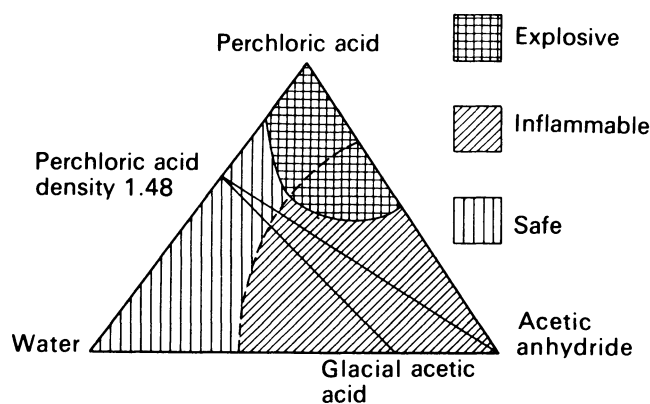


Figure 29 Equilibrium diagram for the water–perchloric acid–acetic anhydride system indicating the explosive, inflammable and safe composition ranges (after Medard et al., 1949)

It can be seen that provided the perchloric acid stock solution used has a specific gravity of 1.48 or less, mixtures with glacial acetic acid cannot be within the explosive zone; more care however, is required with mixtures using acetic anhydride as the explosive zone is closely approached if too much perchloric acid is present. Most recommended electropolishing solutions have compositions lying in the right-hand bottom corner of the diagram and though many are inflammable none should be explosive if correctly prepared.

The following rules must be obeyed for safe working:

1. The perchloric acid stock solution kept in the

laboratory must have a density not exceeding 1.48 (60%).

2. Organic plastic fittings or carbon electrodes *must not* be used with the solution (e.g. p.t.f.e. holder).
3. Perchloric acid solutions should not be used to polish alloys containing bismuth, as an explosive compound may form in this case. Great care must be exercised if electropolishing solutions come into contact with organic compounds. Stopping off solutions should be allowed to dry thoroughly before polishing is started. Care must also be taken to avoid spilling polishing solutions on wooden benches as this makes them liable to spontaneous ignition.
4. An electropolishing apparatus should always include a switch and this must be used in making or breaking a circuit.
5. The polishing solution must be kept in a stoppered bottle when not in use. The bottle must be clearly labelled and carry the date of preparation.
6. In order to avoid risk of overheating, a sufficient volume of liquid must be used in the bath. It is essential to keep the liquid cool (< 35°C) both during the mixing of the perchloric acid with the acetic acid (or anhydride) and also during the *polishing operation* itself.
7. During *mixing*, the eyes of the operator must always be protected by means of a face shield. The perchloric acid must always be added to the other solutions so that the overall concentration is *never* stronger than the final solution. Bottles should *never* be stoppered immediately after mixing solutions.
8. *Polishing* must always be carried out in a fume cupboard with an efficient fan. The polishing cell must be behind a Perspex sheet which is sufficiently large to completely protect the operator's face.
If the circuit is broken by lifting a specimen out of the solution without first switching off, care must be taken to avoid sparking to the cathode which may ignite polishing solutions of certain compositions or cooling solutions like acetone/dry ice mixtures.
9. A carbon dioxide extinguisher must be kept in each laboratory where electropolishing is carried out.

N.B. These regulations are detailed for the common perchloric acid type solutions but they must also be obeyed for other electrolytic or chemical polishing solutions which are potentially explosive, inflammable or poisonous, e.g. solutions containing cyanides.

6.4 Other Reactive Solutions

Any electropolishing solution that contains a strong oxidising agent, e.g. nitric or chromic acid, mixed with an organic chemical such as acetic anhydride or methyl alcohol, can explode during mixing if the exothermic oxidation reaction is allowed to accelerate. There may be an induction period of a few minutes. The following general rules should be followed.

1. The solutions should not be allowed to overheat in use, and especially during mixing the reagents should be cooled with cold running water and the mixing should be slow with effective stirring.
2. Warm or newly mixed solutions should *never* be put in a tightly stoppered bottle.
3. In most cases, except where specified, the

oxidising substance should be added to the reducing substance.

4. Methyl alcohol is preferable to ethyl alcohol if used with nitric acid. The latter forms more unstable solutions which may decompose violently. After approximately 1 month, or when they have become contaminated with metal ions that may act as a catalyst, even methyl alcohol–nitric acid solutions should be discarded. There is also a hazard with methyl alcohol solutions if evaporation losses are allowed to occur. Consequently they should be placed in stoppered bottles.
5. Solutions should never be placed in screw-cap bottles, only in glass stoppered bottles, to minimise risk of explosion.
6. Care should be taken when mixing sulphuric acid and water because of the heat generated. Always add acid to water.

7 STRENGTHS AND PURITIES OF CHEMICALS

In the tables in section 9.1 et seq, all chemicals used should preferably be ANALAR grade, but general-purpose grade is sometimes acceptable. Water should be single (or better double) distilled. Except where otherwise stated, the reagents used should be of such concentration that the specific gravities are those listed in Table 3.

Table 3 Specifications of Reagents for Solutions in Table 9.1 et seq.

Reagent	Concentration (%)	Specific Gravity
Orthophosphoric acid	98	1.84
Sulphuric acid	98.08	1.84
Nitric acid	63.02	1.40
Hydrochloric acid	36.47	1.175
Glacial acetic acid	60.05	1.065
Perchloric acid	57	1.48
Hydrofluoric acid	40	1.13
Hydrogen peroxide	34.02	1.11

8 REFERENCES TO SECTIONS 1 TO 7

- Abrams, H. (1970). *Metallography*, **3**, 375
- Alpers, M. and Vassamillet, L. F. (1968). *J.A.P.*, **39**, 3592
- Andrews, E. H. (1964). *Proc. Roy. Soc.*, **A277**, 562
- Andrews, E. H., Bennett, L. and Markham, A. (1967). *J. Polymer Sci.*, **A5**, 1235
- Andrews, E. H. and Stubbs, J. M. (1964). *J. Roy. Mic. Soc.*, **82**, 221
- Ardell, A. J. (1969). *Trans. A.I.M.E.*, **245**, 1133
- Armond, V. J. and Atkinson, J. R. (1969). *J. Mat. Sci.*, **4**, 509
- Bach, H. (1970). *J. Non-Cryst. Solids*, **3**, 1
- Bach, H. and Schroder, H. (1969). *Z. Physik*, **224**, 122
- Bainbridge, J. E. and Thorne, L. (1970). *J. Nuclear Materials*, **34**, 202
- Barber, D. J. (1970). *J. Mat. Sci.*, **5**, 1
- Bassett, G. A. (1965). *Techniques for Electron Microscopy*, Ed. D. H. Kay, Blackwell, 411
- Bezruk, L. I., Gorokhovski, G. A. and Lipatov, Yu. S. (1968). *Polymer Sci. U.S.S.R.*, **10**, 1665
- Blackburn, M. J. and Williams, J. C. (1967). *Trans. A.I.M.E.*, **239**, 287
- Booker, G. R. (1970). *Ion Beam Thinning Symposium*, London
- Booker, G. R. and Stickler, R. (1962). *Brit. J.A.P.*, **13**, 446
- Bradley, D. E. (1956). *J.A.P.*, **27**, 1399
- Bradley, D. E. (1965). *Techniques for Electron Microscopy*, Ed. D. H. Kay, Blackwell, 96
- Bridges, W. N. and Long, E. L. (1958). *A.S.T.M., Special Tech. Pub.*, **245**, 25
- Broadway, M. J. (1970). Reported by P. J. Goodhew, 1973
- Bruck, L. (1936). *Ann. Phys.*, **26**, 233
- Davis, A. R. (1968). *J.I.M.*, **96**, 61
- Denny, W. H. (1976). Motorola Applications, Note DS 9130 R3
- Dewey, M. A. P. and Lewis, T. G. (1963). *J. Sci. Inst.*, **40**, 385

- Dobson, P. S. and Smallman, R. E. (1966). *Proc. Roy. Soc.*, **A293**, 423
- Dubose, C. K. H. and Steigler, J. O. (1967). *Rev. Sci. Instr.*, **38**, 694
- Fukami, A. and Adachi, K. (1965). *J. Electron Microscopy*, **14**, 112
- Georgieva, I. J., Izotov, V. I. and Handarov, P. A. (1970). *Proc. 7th Int. Congress for Electron Microscopy*, Grenoble, Société Française de Microscopie Electronique, Paris, **2**, 497
- Ginn, B. J. and Brown, E. D. (1965). *Brit. Welding J.*, **12**, 90
- Goodhew, P. J. (1973). *Specimen Preparation in Materials Science*, North-Holland
- Habrovec, F. (1968). *Prakt. Metallog.*, **5**, 18
- Harris, W. J. (1962). *Nature*, **196**, 499
- Heidenreich, R. D., Hess, W. M. and Ban, L. L. (1968). *J. App. Cryst.*, **1**, 1
- Hepfer, W. D. (1966). *Trans A.S.M.*, **59**, 345
- Hill, M. J., Holt, D. B. and Unvala, B.A. (1968). *J. Physics E.*, **1**, 301
- Hock, C. W. (1967). *J. Polymer Sci.*, **A5**, 471
- Hockey, B. J. (1970). *Proc. British Ceram. Soc.*, No. 20, 95.
- Hull, D. (1962). *Phil. Mag.*, **7**, 537
- Jansen, J. and Zeedijk, H. B. (1972). *J. Physics E*, **5**, 973
- Johnston, H. S. and Reid, O. (1971). *J. Microscopy*, **94**, 283
- Jubb, J. T. and Laufer, E. E. (1971). *Met. Trans.*, **2**, 2549
- Karchner, G. H. and Stephenson, E. T. (1967). *Trans A.S.M.*, **60**, 716
- Keast, D. J. and Wilson, A.D. (1966). *J. Sci. Inst.*, **43**, 609
- Kelly, A. and Nutting, J. (1959). *J. Inst. Met.*, **87**, 385
- Keown, S. R. and Dyson, D. J. (1966). *J.I.S.I.*, **204**, 832
- Kirchner, H. O. K. (1969). *J. Inst. Met.*, **97**, 256
- Komoda, T. (1966). *6th International Congress for Electron Microscopy*, Kyoto, Maruzen, Tokyo, **1**, 29
- Larson, J. M., Taggart, R. and Polonis, D. H. (1969). *Rev. Sci. Instr.*, **40**, 1338
- Marikkin, V. A., Myasnikova, L. P. and Tukhvatulina, M. Sh. (1971). *Polymer Sci. U.S.S.R.*, **13**, 1353
- Martin, I. G. (1969). Ph.D. Thesis, Queen Mary College, Univ. of London
- Medard, L., Jacquet, P. A. and Sarlorius, R. (1949). *Rev. Met.*, **46**, 549
- Metals Handbook* (1964). A.S.M.
- Nauta, R. and van Wijngaarden, J. D. (1964). Phillips Technical Report 79.177, EM23
- Nicholson, R. B., Thomas, G. and Nutting, J. (1958). *Brit. J. Appl. Phys.*, **9**, 25
- O'Leary, K. and Geil, P. H. (1967). *J. A. P.*, **38**, 4169
- Peterlin, A. and Sakaoku, K. (1967). *J.A.P.*, **38**, 4152
- Richardson, J. H. (1971). *Optical Microscopy for the Materials Sciences*, Marcel Dekker, N. Y.
- Rosenfield, A. R. and Hahn, G. T. (1970). *Met. Trans.*, **1**, 1080
- Rowcliffe, D. J. and Hill, M. (1974). *J. Mat. Sci.*, **9**, 1569
- Ruznock, J. A. and Hansen, D. (1965). *J. Polymer Sci.*, **A3**, 647
- Sakaoku, K. and Peterlin, A. (1967). *J. Macromol. Sci.*, **B1**, 103
- Sanders, I. (1969). M.Sc. Thesis, University of Birmingham
- Savanick, G. A. (1967). *Rev. Sci. Instr.*, **38**, 43
- Schoone, R. D. and Fischione, E. A. (1966). *Rev. Sci. Instr.*, **37**, 1351
- Shirai, S. (1943). *Proc. Phys.-Maths. Soc., Japan*, **25**, 633
- Smithells, C. J. (1967). *Metals Reference Book*, Butterworths, London
- Spurling, R. A., Rhodes, C. G. and Williams, J. C. (1974). *Met. Trans.*, **5**, 2597
- Stevens, R. (1970). *J. Mat. Sci.*, **5**, 474; *ibid.* (1971), **6**, 324
- Stickler, R. and Booker, G. R. (1963). *Phil. Mag.*, **8**, 859
- Stobbs, W. M. (1969). *J. Physics E*, **2**, 202
- Thomas, G. (1961). *J. Inst. Met.*, **90**, 57
- Thomas, G. and Whelan, M. J. (1961). *Phil. Mag.*, **6**, 1103
- Thon, F. (1971). *Electron Microscopy in Materials Science*, Ed. U. Valdré, Academic Press, 570
- Van Torne, L. I. and Thomas, G. (1964). *Acta Met.*, **12**, 601
- Trillat, J. J. (1964). *Ionic Bombardment, Theory and Applications*, Ed. J. J. Trillat, Gordon and Breach, N. Y., 13
- Villagrana, R. E. and Thomas, G. (1965). *Phys. Stat. Sol.*, **9**, 499
- West, J. M. (1970). *Brit. Corr. J.*, **5**, 65
- Whitton, J. L. (1965). *J.A.P.*, **36**, 3917
- Woodilla, J. E. and Averbach, B. L. (1968). *Acta Met.*, **16**, 255
- Youngblood, J. L. (1969). *Trans A.S.M.*, **62**, 1019

9 TABLES OF SPECIMEN PREPARATION TECHNIQUES

The following tables list various techniques and conditions used to prepare thin foils of a wide range of materials. The chemical and electrochemical specimen preparation techniques have been divided into eight classifications as follows:

1. *Chemical*—prior to final polish.
2. *Chemical polish*—chemical thinning directly to the thin foil.
3. *Jet*—electro-dishing discs prior to final polish.
4. *Chemical jet*—dishing by chemical means.
5. *Chemical-jet polish*—chemical thinning via a jet of solution directly to the thin foil.
6. *Jet polish*—jet electropolish to perforation, usually a submerged jet.
7. *Electrothin*—rapid initial electropolish to reduce quickly specimen thickness prior to final polish.
8. *Electropolish*—final electropolish to perforation of either disc or sheet specimens.

Other preparation methods such as ion-beam thin-

ning are listed specifically. Where a voltage is quoted it refers to the situation with the specimen in the solution. Most solutions either require slow stirring or the specimen to be moved very gently up and down. These operations have the effect of decreasing downward streaming of the viscous layer close to the specimen which produces a rippled surface of the type shown in figure 17e.

Note that it may be necessary to vary slightly the voltages quoted because of small temperature variations, electrode separation, etc. In many cases the success can be critically dependent on exact composition of the solution. Sometimes solutions improve with use because the conductivity is increased by the additional ions. Others must be used immediately and deteriorate with time and/or use due to chemical changes within the solution.

The references listed after sections 9.1 to 9.4 are complete with titles to help indicate whether a reference deals primarily with electron microscopy or whether the microscopy was a small part of an investigation of some other material property.

9.1 Elements and Compounds

MATERIAL AND REFERENCE	METHOD	CONDITIONS
<i>Aluminium, Al</i>		
Al (Murr, 1973)	<i>Chemical polish:</i> 90 parts phosphoric acid 25 parts nitric acid 25 parts sulphuric acid Specimen dissolved in solution until it floats to surface. Rinsed in alcohol and water	> 90°C
Al, bicrystals (Kegg et al., 1973)	<i>Jet:</i> 10% nitric acid 90% water <i>Electropolish:</i> 10% perchloric acid 20% glycerol 70% methanol	100 V 15 V, room temp.
Al (Parker, 1972)	<i>Electropolish:</i> 20% perchloric acid 80% ethanol	0°C
Al, cold-worked (Michels and Ricketts, 1967)	<i>Electropolish:</i> 26% nitric acid 74% methanol	7–9 V, 0.15 A/cm ² stainless steel cathode (beaker) 10–15°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Al (Bay, 1970)	<i>Electropolish:</i> 79 % ethanol 11 % 2-butoxyethanol 8 % perchloric acid 2 % water	15°C window method
Al (Ham and Wright, 1964)	<i>Chemical polish:</i> exposed face of specimen dissolved in agitated solution of 2 g/l of sodium hydroxide in water at room temperature. Removes 1 μm of metal per hour	
Al, quenched (Edington and Smallman, 1965)	<i>Electropolish:</i> 20 % perchloric acid 80 % acetic acid	– 10°C window method
Al (Rider and Foxon, 1966)	<i>Electropolish:</i> 10 % glycerol 20 % perchloric acid 70 % ethanol	0°C
Al, quenched (Edington and West, 1966)	<i>Electropolish:</i> 20 % perchloric acid 80 % methanol	– 10°C window method
Al, rolled strip (de Jager et al., 1972)	<i>Electropolish:</i> 20 % perchloric acid 80 % methanol	Window method – 20°C, continuous agitation
Al and Al alloys (Hacking et al., 1969)	<i>Jet polish:</i> 40 % acetic acid 30 % orthophosphoric acid 20 % nitric acid 10 % water Fresh electrolyte etches. This is prevented by dissolving a little copper in the solution	105–110 V 4.2–4.6 A/cm ² – 12 to – 5°C special jetting unit described
Al and Al alloys (Davies and Williams, 1968)	<i>Electropolish:</i> 62 % orthophosphoric acid 24 % water 14 % sulphuric acid 160 g/l chromium trioxide	9–12 V, 70°C window method
Al alloys (Conserva and Fiorini, 1973)	<i>Electropolish:</i> 75 % methanol 25 % nitric acid	15 V, 35°C 1 A/cm ²
Al, Al alloys (Davis, 1968)	<i>Jet polish:</i> 10 % perchloric acid 20 % glycerol 70 % ethanol	12 V, 18°C submerged jet technique
Al–matrix composites	Specimens sectioned from bulk by spark	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
(Prewo and McCarthy, 1972)	electro-machining followed by final thinning in an ion micro-milling instrument	
Al alloys + intermetallic particles (Davis, 1968)	<i>Jet polish:</i> 20 % perchloric acid 80 % ethanol	– 30°C submerged jet technique
Al–stainless steel wire composite (Pinnel and Lawley, 1968)	<i>Jet:</i> 15 % nitric acid 85 % water	100 V
	<i>Electropolish:</i> 15 % perchloric acid 85 % ethanol	13 V
Al–Al ₃ Fe eutectic (Adam and Hogan, 1975)	<i>Electropolish:</i> 20 % perchloric acid 80 % methanol	– 50°C
Al–Al ₃ Ni (Garmon et al., 1973)	<i>Electropolish:</i> 75 % methanol 25 % nitric acid	40 V, – 70°C
Al–Al ₃ Ni eutectic composite (Breinan et al., 1972)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	– 10°C washed in methanol
Al and SAP alloys (Mori and Meshii, 1969)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	19–20 V, below 30°C aluminium cathode
Al–Al oxide (Grove et al., 1972)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	Room temperature
Al–Al oxide (Hansen 1969a and b)	<i>Electropolish:</i> 10 % perchloric acid 90 % ethanol	20 V, stainless steel cathode p.t.f.e. holder
Al–20 wt. % Ag (von Heimendahl and Schneider, 1970)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	17 V, 4°C window method
Al–Au alloys (splat cooled) (Toda and Maddin, 1969)	<i>Electropolish:</i> 20 % perchloric acid 80 % methanol	Window method 16–18 V 0.1 A/cm ² , – 65 to – 55°C, low temp. important
Al–Cu alloys (Gleiter, 1970)	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	15 V, – 27°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Al-0.39 wt. %Cu (Gleiter, 1969a)	<i>Electropolish:</i> 20 % perchloric acid 80 % methanol Initial thinning by mechanical grinding. Foils soaked in a phosphoric acid bath for 15 min to remove deformed surface layers before electropolishing	12 V, 0°C
Al-0.46 wt. %Cu (Gleiter, 1969b)	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	15 V, -27°C Bollmann method
Al-3 %Cu (Phillips, 1973)	<i>Chemical polish:</i> quenched sample 94 % phosphoric acid 6 % nitric acid <i>Chemical polish:</i> aged sample 50 % nitric acid 49 % water 1 % hydrofluoric acid	
Al-4 %Cu (Sahoo and Lund, 1973)	<i>Electropolish:</i> 50 % nitric acid 50 % methanol 1ml hydrochloric acid per 50 ml solution	
Al-CuAl ₂ (Garmong and Rhodes, 1974)	<i>Electropolish:</i> 75 % methanol 25 % nitric acid	35 V, -40°C
Al-CuAl ₂ (Yue et al., 1968)	<i>Jet polish:</i> 10 % perchloric acid 90 % methanol	12 V, 0.026 A/cm ² , -10°C
Al-CuAl ₂ (Livingston et al., 1970; Davies and Hellawell, 1969; Weatherly, 1968)	<i>Jet:</i> 10 % nitric acid 20 % orthophosphoric acid 30 % acetic acid 40 % water Followed by brief electropolishing in: 30 % nitric acid 70 % methanol	70 V, room temp. 30 V, -40°C
Al-Cu-Mg eutectic (Garmong and Rhodes, 1972)	<i>Electropolish:</i> 25 % nitric acid 75 % methanol	35-40 V, -40°C
Al-Cu-Mg-Mn alloys (Robinson and Hunter, 1972)	<i>Chemical:</i> 40 % hydrochloric acid 60 % water <i>Electropolish:</i> 722 ml orthophosphoric acid (85 %) 137 ml sulphuric acid (98 %)	9-10 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	158 g chromium trioxide 134 ml water	
Al–Cu–Si (Gulden and Nix, 1968)	<i>Electropolish:</i> 50 % methanol 50 % nitric acid 20ml/l hydrochloric acid	Approx. 6 A/cm ² stainless steel cathode
Al–Fe alloys (Jacobs et al., 1974)	<i>Electropolish:</i> 10 % perchloric acid 20 % glycerol 70 % ethyl alcohol	
Al–Li (Williams and Edington, 1974)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethyl alcohol Examine within 5 min of preparation	15 V, 0°C
Al–0.9 %Mg wires (Dexter and Greenfield, 1971)	<i>Jet:</i> 10 % nitric acid 90 % water	90 V
	<i>Electropolish:</i> 7 % perchloric acid 10 % ethylene glycol 13 % water 70 % ethanol	15–18°C, agitation
Al–1 %Mg (Hudson and Makin, 1965)	<i>Electropolish:</i> 20 % perchloric acid 80 % methanol	0°C
Al–Mg–Si (Pashley et al., 1966)	<i>Electropolish:</i> 64 % ethanol 18 % perchloric acid 18 % glycerol	20 V, 0°C semicircular Al cathode
Al ₃ Ni (Broom and Davies, 1975)	<i>Electropolish:</i> 5 % perchloric acid 95 % ethanol	Cooled
Al oxide (Hockey, 1972)	Ion bombardment of polycrystalline slice. Ar ions at 5–6 kV, 100μA, incident angle 20°	
Al ₂ O ₃ (Barber, 1970)	Ion bombardment	
α-Al ₂ O ₃ (Wilkes et al., 1967)	Discs dimpled in several places with an ultrasonic drill. Initial chemical thinning by immersion in orthophosphoric acid until minimum thickness 20μm. Final perforation in jet apparatus with same solution. Specimen then boiled for 5 min in distilled water, and dried	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Al oxide (Barber and Tighe, 1965)	<i>Chemical jet polish:</i> Orthophosphoric acid used as follows: (1) discs parallel to basal or rhombohedral planes (2) discs parallel to other planes Carbon film evaporated onto specimen to prevent charging-up in beam	450–460°C 500–510°C
Al–Zn (Melton and Edington, 1974)	<i>Electropolish:</i> 15 % perchloric acid 85 % methanol	–60°C
Al–Zn (Anantharaman et al., 1974)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	–25°C
Al–Zn (Cook and Cundy, 1969)	<i>Electropolish:</i> 10 % perchloric acid 20 % glycerol 70 % ethanol	20 V, 0°C window method
Al–Zn–Mg (De Ardo and Townsend, 1970)	<i>Jet polish:</i> 33 % nitric acid 67 % methanol	10 V, –20°C
Al–Zn–Mg (Stubbington and Forsyth, 1966)	<i>Electropolish:</i> 10 % perchloric acid 10 % glycerol 10 % water 70 % ethanol	
Al–Zn–Mg; heavily cold-worked (Bricknell, private communication)	<i>Jet polish:</i> 25 % nitric acid 75 % methanol	25 V, –50°C
Al–Zn–Mg–Ti (Grove and Judd, 1973)	<i>Electropolish:</i> 17 % perchloric acid 83 % absolute ethanol	12 V, –30°C
Al–0.5wt. %Zr (Ryum, 1969)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	20 V, <15°C
Beryllium, Be Be wire (Chin, 1975)	<i>Jet polish:</i> 6 % nitric acid 1 % hydrofluoric acid 93 % methanol	30 V, 0.2 A/cm ² room temp.
Be (Rennhack, 1974)	<i>Electropolish:</i> 375ml ethylene glycol 40ml nitric acid 8ml hydrochloric acid 8ml sulphuric acid 25ml water	8 V, 2.0 A/cm ²

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Be (Wheeler and Price, 1967)	<i>Electropolish:</i> 2% hydrochloric acid 2% nitric acid 2% perchloric acid 94% ethylene glycol	Room temp. stainless steel cathode with area twice speci- men area
Be (Andrews and Radcliffe, 1967)	<i>Jet:</i> 5% nitric acid 1% sulphuric acid 1% hydrochloric acid 31% ethylene glycol 62% ethanol <i>Electropolish:</i> 9% nitric acid 1. 5% sulphuric acid 1. 5% hydrochloric acid 88% ethylene glycol	9–12 V, room temp.
Be (Walters and Fuller, 1963)	<i>Chemical:</i> 5% sulphuric acid 10% chromium trioxide (by weight) 85% orthophosphoric acid <i>Electropolish:</i> 5% $\left\{ \begin{array}{l} 50\% \text{ chromium trioxide} \\ 50\% \text{ water (by weight)} \end{array} \right.$ 60% orthophosphoric acid 35% glycerol (added slowly to above acids) Wash specimens in hot water. Cut under ethanol and clean ultrasonically in ethanol	70°C 30 V, 50–80°C gentle agitation
Be, Be–Cu (LeHazif et al., 1973)	<i>Electropolish:</i> 80% ethyl alcohol 20% perchloric acid	40 V, –30°C
Be–0.95wt. %Fe (Levine and Lütjering, 1971)	<i>Jet polish:</i> 5ml nitric acid 1ml sulphuric acid 1ml hydrochloric acid 33ml ethylene glycol 67ml ethanol	84 V
<i>Bismuth, Bi</i> Bi (Alcouffe et al., 1970)	<i>Electropolish:</i> in a saturated solution of sodium chloride in water plus 2% hydrochloric acid	3–7 V, –10 °C tantalum cath- ode

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Bi₂Te₃ (Moon and Stickler, 1967)	<i>Electropolish:</i> 53 % water 38 % glycerol 5 % sodium hydroxide 4 % tartaric acid	10 V
Bismuth titanate, Bi₄Ti₃O₁₂ (van Landuyt et al., 1969)	<i>Chemical polish:</i> conc. hydrochloric acid	
Calcium, Ca CaF₂ (Evans, 1963)	<i>Chemical polish:</i> A slice of crystal 0.5mm thick is floated on hydrochloric acid until only small fragments remain <i>Mechanical:</i> Crystal is cleaved with a razor blade along octahedral cleavage planes. Areas near edges are thin enough for TEM	
Lunar and terrestrial calcic plagioclases (Heuer et al., 1972)	Ion-beam thinning	
Cadmium, Cd Cd (Puttick and Rudman, 1970)	<i>Chemical:</i> 20 % nitric acid 80 % ethanol <i>Electropolish:</i> 44 % orthophosphoric acid 56 % triple distilled water	Procedure extensively described 1.5 A/cm ² nickel cathode wash in water
Cd (Kirchner, 1969)	<i>Jet:</i> 10 % glycerol 20 % perchloric acid 30 % methanol 40 % ethanol <i>Electropolish:</i> 10 % nitric acid 40 % methanol 50 % ethanol	20 V
CdS (Dash, 1970)	<i>Chemical jet:</i> crystals rapidly etched in dilute hydrochloric acid. Final polish with slower etch in hot orthophosphoric acid	
CdS (Holt et al., 1966)	<i>Chemical polish:</i> concentrated chromic acid at 95°C	Attack is slow

MATERIAL AND REFERENCE	METHOD	CONDITIONS
CdSe (Baubinas et al., 1973)	Crystals stiffened by epoxy resin and sliced using piezoelectric ultramicrotome	
CdTe, ZnTe (Lilienthal et al., 1974)	<i>Chemical polish:</i> 0.5% bromine 99.5% methyl alcohol	24°C intensive agitation
<i>Carbon, C</i> Carbon (vitreous) (Hannink, 1970)	Slices cut by diamond wheel. Discs cut and dished with ultrasonic drill. Final thinning chemical or electrolytic	
Carbon fibres (Donnet et al., 1973)	Fibres thinned with boiling nitric acid (68%) for 48h until thin flakes remained. They are the heart of the original fibre	
Carbon fibres (Wicks, 1971)	Fibres were flame-polished in an alumina crucible using an oxygen-hydrogen gas mixture	
Coals and coal extracts (Evans et al., 1972)	Finely ground samples of the coals adhered to clean copper specimen grids	
Diamond (synthetic) (Phaal and Zuidema, 1966)	Crystals are placed in a combustion boat which is heated to 750°C in a stream of oxygen. After 10–15 min, the crystals disintegrate and suitable fragments are selected with the aid of an optical microscope	
Single crystal graphite (Baker and Harris, 1973)	Crystal mounted on glass slide and successive layers removed with scotch tape until electron transparent section remained. Crystal floated off onto water surface and picked up on TEM grid	
Carbons and graphites (Price, 1974)	Thin sections cut from massive samples and further thinned by ion sputtering	
Graphite, fine-grained (Stevens, 1971b)	Ion bombardment	
Pyrolytic graphite (Saito and Tsuzuku, 1973)	Thin flakes prepared by cleaving crystals using scotch tape. Flakes sandwiched between two Mo grids to improve thermal conduction	
Graphite fibres (Barclay and Bonfield, 1971)	Fibres were vibrated ultrasonically and the detached segments caught on grids	
Graphite, single crystal (Turnbull and Stagg, 1966)	Thin foil specimens prepared by cleaving on transparent sticky tape. Tape removed by soaking in chloroform	
<i>Cerium, Ce</i> CeCo ₅ (Riley, 1974)	<i>Jet:</i> 10% hydrochloric acid 90% water	50 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	<i>Electropolish:</i> to perforation: 15 % perchloric acid 85 % acetic acid Wash in methanol Final step: ion bombardment around perforation	10 V
<i>Chromium, Cr</i> Cr (Brinkman and Pitt, 1966)	<i>Electropolish:</i> 20 % perchloric acid 80 % acetic acid Optimum polishing conditions determined from experience by noting the presence and the colour of the viscous layer formed during polishing	4 V, 5°C, stainless steel cathode
Cr (Ryan and Johnstone, 1970)	<i>Electropolish:</i> 1 part perchloric acid 5 parts acetic acid 5 parts butyl cellosolve	35–40 V
Cr-base alloys (Chung and Chaturvedi, 1974)	<i>Jet polish:</i> 5 % perchloric acid 95 % methanol	–40° to –50°C
Cr alloys (Gidley and Davies, 1967)	<i>Jet/electropolish:</i> 90 % methanol 10 % perchloric acid	18 V for jet 10 V for final polish
Cr, Cr–Fe, Cr–Re (Reid et al., 1967; Reid and Gilbert, 1965)	<i>Jet:</i> 10 % hydrochloric acid 90 % water <i>Electropolish:</i> 5 % perchloric acid 95 % acetic acid	28 V
Cr–Co–Ni alloy (Ravindran and Chaturvedi, 1975)	<i>Jet polish:</i> 10 % perchloric acid 90 % methanol	–40 to –50°C
<i>Cobalt, Co</i> Co (Toth et al., 1964)	<i>Electropolish:</i> 23 % perchloric acid 77 % acetic acid	22 V, < 30°C stainless steel cathode
Co (Votava 1961–1962)	<i>Electropolish:</i> 50 % orthophosphoric acid 50 % water	
Co alloys (Lux and Bollmann, 1961)	<i>Electropolish:</i> 2 % perchloric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	8 % citric acid 10 % propanol 50g/l sodium thiocyanate	
CoAl, CoAl + Co (Peacock, 1973)	<i>Jet:</i> 15 % hydrochloric acid 85 % water	100 V
	<i>Electropolish:</i> 5 % perchloric acid 95 % ethanol	5 V room temp.
Co–CoAl eutectic (Cline, 1967)	<i>Electropolish:</i> 23 % perchloric acid 77 % acetic acid	22 V, 0°C
Co–Cr alloys (Ahier, 1970)	<i>Jet/electropolish:</i> 22 % perchloric acid 14 % butoxy ethanol 64 % ethanol	20 V for jet 11 V for final polish platinum cathode p.t.f.e. holder
Co–Cr–C eutectic alloys (Thompson and Lemkey, 1970)	<i>Electropolish:</i> 15 % perchloric acid 85 % acetic acid	10°C
Co–Fe (Mahajan and Chin, 1973)	<i>Chemical:</i> 50 % orthophosphoric acid 50 % hydrogen peroxide	
	<i>Electropolish:</i> 80 % methanol 20 % perchloric acid	–20°C
Co–Fe, Co–Ni (Tisone, 1973)	<i>Electropolish:</i> 80 % methyl alcohol 20 % perchloric acid	10 V, less than –20°C
Co–NiCr–Mo (Youngblood, 1969)	<i>Electrothin:</i> 76 % methanol 19 % sulphuric acid 5 % orthophosphoric acid	3–5 V
	<i>Electropolish:</i> 14 % hydrochloric acid 86 % methanol	40 V
Co–Ni–Cr–Ti alloy (Lloyd et al., 1975)	<i>Electropolish:</i> 15 % perchloric acid 85 % methyl alcohol	–50°C
CoO (Clauer et al., 1971)	<i>Chemical jet polish:</i> orthophosphoric acid	70–80°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	{100} slabs obtained by cleaving specimens. Initial mechanical grinding and then jet polish	
CoPt (Stevens, 1971)	<i>Electropolish:</i> 20 % hydrochloric acid 80 % water saturated with sodium chloride	7.5 V(a.c.)
Copper, Cu Cu (Doner et al., 1974)	<i>Chemical:</i> 50 % nitric acid 25 % acetic acid 25 % orthophosphoric acid <i>Jet polish:</i> 20 % nitric acid 80 % methanol	20°C Cooled in dry ice and methanol
Cu (Petrov, 1973)	<i>Chemical:</i> 33 % nitric acid 33 % phosphoric acid 33 % acetic acid <i>Electropolish:</i> 45 % phosphoric acid 55 % water	30°C < 10°C
Cu single crystals (Cockayne et al., 1971)	<i>Jet:</i> 33 % orthophosphoric acid 67 % water <i>Electropolish:</i> 50 % orthophosphoric acid 50 % water	0.9 V, 20°C
Cu single crystals (Essmann and Rapp, 1973)	<i>Electropolish:</i> 67 % methanol 33 % nitric acid or <i>Electropolish:</i> 50 % phosphoric acid 50 % water	– 30°C Room temp.
Cu (Hancock, 1968)	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	1.5 V, – 25 °C, 0.11 A/cm ² , disc specimens; sol- ution stirred
Cu (Orlová and Čadek, 1970)	<i>Chemical:</i> nitric acid or	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	30ml nitric acid 20ml orthophosphoric acid 20 ml acetic acid 2ml sulphuric acid 1ml hydrochloric acid <i>Electropolish:</i> 20% nitric acid 80% methanol	0.21 A/cm ² , -20°C
Cu (wire) (Glenn and Duff, 1965)	<i>Electropolish:</i> 60% orthophosphoric acid 40% water <i>or</i> <i>Electropolish:</i> 30% nitric acid 70% methanol <i>NOTE: potential explosion hazard</i>	7 V, 25°C wire embedded in plated nickel < -20°C wire embedded in plated copper, stainless steel cathode (beaker)
Cu (Higgins, 1971)	<i>Electropolish:</i> 30% water 70% orthophosphoric acid	
Cu (Mahajan et al., 1970)	<i>Jet:</i> 54% orthophosphoric acid 46% water <i>Electropolish:</i> *Disapol D2	15°C, static bath
Cu (Roberts, 1969)	<i>Electropolish:</i> 10% orthophosphoric acid 90% water	8 V, 0°C
Cu (Mazey and Barnes, 1968)	<i>Electropolish:</i> 34% water 66% orthophosphoric acid Washed successively in 10% orthophosphoric acid, water and methanol	
Cu-9wt.% Al (Varschavsky et al., 1975)	<i>Electropolish:</i> 50% phosphoric acid 50% ethyl alcohol	
Cu-Al alloys (Poppewell and Crane, 1971)	<i>Electropolish:</i> 20% nitric acid 80% ethanol	

*Disapol is the registered trademark of Struers Scientific Instruments, Copenhagen, Denmark

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Cu–Al alloys (Brimhall and Huggins, 1965; Brimhall et al., 1966)	<i>Electropolish:</i> 40 % orthophosphoric acid 60 % water	
Cu–Al martensites (Swann and Warlimont, 1963)	<i>Chemical:</i> 40 % nitric acid 10 % hydrochloric acid 50 % orthophosphoric acid <i>Electropolish:</i> 33 % nitric acid 67 % methanol <i>N.B.</i> Solution should be mixed slowly and kept cool during mixing to avoid ex- plosive reaction	15–20 V, –20°C
Cu–Al eutectoid (Rao et al., 1974)	<i>Jet:</i> 50 % phosphoric acid 50 % water <i>Electropolish (2s):</i> 67 % methanol 33 % nitric acid	15 V, 0°C 30 V, –40°C
Cu–Al–Fe (Dunlop and Taplin, 1972)	<i>Jet:</i> 33 % nitric acid 67 % methanol <i>or</i> 20 % nitric acid 80 % water <i>Electropolish:</i> 33 % nitric acid 67 % methanol	8 V, <10°C 2 A 6 V, –20°C
Cu–Al–Ni (Swann, 1966)	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	12 V, –40°C
Cu–Al–Si–Co (Fleck et al., 1975)	<i>Jet polish:</i> 67 % methanol 33 % nitric acid	–10°C
α -CuAl (Charsley and Desvaux, 1966)	<i>Electropolish:</i> 50 % orthophosphoric acid 50 % water	2 V, 0.5 A/cm ² copper cathode
Cu and Cu–Ag (Räty et al., 1966)	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	5–20 V, –30°C
CuAuI (Pashley et al., 1969)	<i>Electropolish:</i> 25g chromium trioxide 7ml water 133ml acetic acid	25 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Cu ₃ Au (Morris et al., 1974)	<i>Electropolish:</i> 133ml glacial acetic acid 25g chromium trioxide 7ml water	
Cu ₃ Au (Sauthoff, 1973)	<i>Jet polish:</i> 11 % perchloric acid 89 % acetic acid	17°C, 24 V current interrupted for 0.1 s at 5 Hz
Cu ₃ Au (Sakai and Mikkola, 1971)	<i>Electrothin:</i> 110ml acetic acid 10ml perchloric acid <i>Electropolish:</i> 20g chromium trioxide 7ml water 135ml acetic acid Some foils had a back-deposition of gold on the surface	22 V, 1 A/cm ² , 20°C 20 V, 0.5 A/cm ² , 18°C slight agitation
Cu ₃ Au (Camanzi, 1970)	<i>Electropolish:</i> 67.5g potassium cyanide 15g Rochelle salt 15g potassium ferrocyanide 18.5ml orthophosphoric acid 2.5ml ammonium hydroxide per litre of water	45–50 V, 55–62°C
Cu–Be (Phillips and Tanner, 1973)	<i>Jet polish:</i> 50 % orthophosphoric acid 50 % water	60 V
Cu–Be (Mishima and Shiromizu, 1968)	<i>Electropolish:</i> orthophosphoric acid saturated with chromic acid	
Cu–2 %Be–0.3 %Co (Tanner, 1966)	<i>Jet polish:</i> 33 % water 67 % orthophosphoric acid	
Cu–1.9wt. %Be (Bonfield, 1967)	<i>Electropolish:</i> 30 % nitric acid 70 % ethanol	–20°C
Cu–3 %Co (Phillips, 1966 and 1966a)	<i>Jet polish:</i> 33 % water 67 % orthophosphoric acid	60–80 V
Cu–Fe (Matsuura et al., 1973)	<i>Electropolish:</i> 6 parts ethanol 1 part nitric acid	–30°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Cu–Ga alloys (Delaey et al., 1968; Sargent et al., 1968)	<i>Chemical:</i> 40 % nitric acid 10 % hydrochloric acid 50 % phosphoric acid	
	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	15 V, –20 to –40°C
	<i>Explosive mixture</i> ; stir constantly	
Cu–Ga (Ashbee et al., 1967; Ashbee and Vassamillet, 1967)	<i>Jet polish:</i> 20 % perchloric acid 80 % water	Dual-jet system
	<i>or</i>	
	15 % nitric acid 85 % methanol	
β -Cu–Ga alloys (Saburi and Wayman, 1965)	<i>Electropolish:</i> 30 % nitric acid 70 % methanol	–25°C
Cu–Ge alloys (Kotval and Honeycombe, 1968)	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	12 V, –20°C 2 copper plate cathodes
Cu–In alloys (Corderoy and Honeycombe, 1963–64)	<i>Electropolish:</i> 34 % nitric acid 66 % methanol	5 V window method
Cu–Mn–Al (Lapworth and Jakubovics, 1974)	<i>Jet:</i> 33 % orthophosphoric acid 67 % water	120 mA
	<i>Electropolish:</i> 30 % nitric acid 70 % methanol	–30°C, 5– 6 V
Cu–Ni alloys (Vowles et al., 1973)	<i>Electropolish:</i> 20 % nitric acid 80 % ethanol	
Cu–Ni–Fe (Livak and Thomas, 1974)	<i>Chemical:</i> 20ml acetic acid 10ml nitric acid 4ml hydrochloric acid	
	<i>Jet polish:</i> 75g chromium trioxide 400ml acetic acid 12ml water	10°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Cu–Ni–Mn (Shapiro et al., 1974)	<i>Jet polish:</i> 1300ml orthophosphoric acid 650g chromium trioxide	60°C
	<i>or</i> 25–30 % nitric acid 70–75 % methanol	–40 to –60°C ultra-dry conditions
Cu–Ni–Sn (Schwartz et al., 1974)	<i>Electropolish:</i> 67ml methanol 30ml nitric acid	–30°C
Cu–Ni–Fe (Butler and Thomas, 1970)	<i>Chemical:</i> 20ml acetic acid 10ml nitric acid 4ml hydrochloric acid Surface deposit removed by immersion in this solution diluted 50/50 with water	
	<i>Electropolish:</i> 50g chromium trioxide 260ml acetic acid 8–10ml water	20 V, 10°C
Cu–Ni–Fe alloys (Ham et al., 1967)	<i>Electropolish:</i> 60–80 % methanol and nitric acid (higher methanol with higher copper contents) Wash in ethanol at –40°C	6 V for sheet specimen, 10 V for discs –40 to –20°C stainless steel cathodes
Cu ₂ O (Vagnard and Washburn, 1968)	<i>Chemical:</i> 90 % orthophosphoric acid 10 % nitric acid	
	<i>Chemical polish:</i> 80 % orthophosphoric acid 10 % nitric acid 10 % water	0°C, wash in water and alcohol
Oxide film on Cu–Al–Si alloy (Sanderson and Scully, 1970)	<i>Electropolish:</i> Disapol E2* Film first stripped from metal surface, then electropolished	Copper cathode
CuPt (Mitchell et al., 1973)	<i>Electropolish:</i> 0.1 normal sodium hydroxide	70 V, 60 Hz, room temp.

* Disapol is the registered trademark of Struers Scientific Instruments, Copenhagen, Denmark.

MATERIAL AND REFERENCE	METHOD	CONDITIONS
CuPt (Corke et al., 1969)	<i>Electropolish:</i> 100ml saturated solution of calcium chloride add in order: 73ml water 45ml hydrochloric acid 25ml perchloric acid (70%) 1g cuprous nitrate	10 V (3–5 Hz) 0.2–0.4 A/cm ² room temp. Pt cathode
Cu–5wt. %Si (Kinsman et al., 1971)	<i>Electropolish:</i> 2 parts orthophosphoric acid 1 part water hydrofluoric acid After polishing, the foils were cleaned by dipping in orthophosphoric acid and then in ethanol	10 V room temp.
Cu–Si alloys (Singh Deo and Barrett, 1969; Nordström and Barrett, 1969)	<i>Chemical:</i> dilute nitric acid <i>Electropolish:</i> 33 % nitric acid 67 % methanol	6 V, < –25°C
Cu and Cu–SiO ₂ (Stobbs, 1969)	<i>Jet:</i> 20 % orthophosphoric acid 80 % water <i>Electropolish:</i> 50 % orthophosphoric acid 50 % water	110 V 1.2 V
Cu–Ti alloys (Laughlin and Cahn, 1975)	<i>Jet polish:</i> 33 % nitric acid 67 % methyl alcohol	15 V, –50°C platinum cathode
Cu–3.2at. %Sn (Ham and Jaffrey, 1968)	<i>Electropolish:</i> 25 % nitric acid 75 % methanol	12 V, –20°C
Cu–5 %Sn (phosphor bronze) (Tisone et al., 1970)	<i>Electropolish:</i> 1 part nitric acid 2 parts methanol	12 V, –20°C
Cu–16.5at. %Sn (de Bondt and Deruyttere, 1967)	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	8–9 V, –60°C disc specimens
Cu–ThO ₂ (Peterson et al., 1974)	<i>Electrothin:</i> 70 % methanol 30 % nitric acid <i>Jet polish:</i> 75 % phosphoric acid 25 % water	–30°C Room temp.

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Cu-Ti alloys (Cornie et al., 1973)	<i>Jet polish:</i> 750ml acetic acid 300ml phosphoric acid 150g chromic acid 30ml distilled water	30-40 V, 45-55 mA twin-jet polisher
Cu - 3.6wt. %Ti (Michels et al., 1972)	<i>Jet:</i> 1 part nitric acid 2 parts water	40 V, 1 A, room temp.
	<i>Electropolish:</i> 1 part nitric acid 3 parts methanol	20 V, 100 mA, -40°C tantalum strip cathode
Cu - Zn (Cornelis and Wayman, 1974)	<i>Electropolish:</i> orthophosphoric acid saturated with chromium trioxide	6-10 V, 50-80°C stainless steel cathode
	<i>or</i>	
	33 % nitric acid 67 % methanol	8-12 V, -30 to -60°C stainless steel cathode
Cu - Zn alloys (Cu-rich) (Hawbolt and Massalski, 1970)	<i>Chemical:</i> 40 % nitric acid 10 % hydrochloric acid 50 % orthophosphoric acid	
	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	15 V, 0°C
	<i>or</i>	
	10 % potassium cyanide 90 % water	10 V(a.c.), room temp. graphite elec- trode
	Both electrolytes good; KCN gave more rapid polish	
Cu-30%Zn (Grace et al., 1968)	<i>Electropolish:</i> 35 % nitric acid 65 % methanol	0.5 A/cm ² , -30°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Cu-33%Zn (70-30 α -brass) (Evans and Wilshire, 1970)	<i>Electropolish:</i> 33 % nitric acid 67 % methyl alcohol	4 V, -10°C
Cu-Zn (β -brass) (Hornbogen and Warlimont, 1967)	<i>Electropolish:</i> 75 % methanol 25 % nitric acid	-30°C initial -60°C final
Cu-rich γ -brasses (Michell et al., 1971)	<i>Electropolish:</i> 25g chromium trioxide 133ml acetic acid 7ml water	Room temp.
α -brass (Taplin and Barker, 1966)	<i>Electropolish:</i> fresh Disapol D2*	30 V, 5°C p.t.f.e. holder
β -brass (Rinnovatore and Brown, 1967)	<i>Jet:</i> 14 % nitric acid 85 % water discs cleaned in an acetic acid-chromium trioxide solution <i>Electropolish:</i> 60 % orthophosphoric acid 20 % ethanol 20 % water	
β -brass (Cupschalk and Brown, 1966)	<i>Jet:</i> orthophosphoric acid <i>Electrolytic cleaning:</i> 750ml acetic acid 210ml water 180g chromic acid <i>Electropolish:</i> 600ml orthophosphoric acid 300ml ethanol 200ml water Specimen dipped into the following solution: 25g chromium trioxide 7ml water 133ml glacial acetic acid immediately prior to examination	
Cu-40at. %Zr (Vitek et al., 1975)	<i>Electropolish:</i> 20 % nitric acid 20 % glycerin 60 % methanol	-30°C
Cu-Zr (Phillips, 1974)	<i>Jet polish:</i> 50 % orthophosphoric acid 50 % water	65 V, cooled

* Disapol is the registered trademark of Struers Scientific Instruments, Copenhagen, Denmark.

MATERIAL AND REFERENCE	METHOD	CONDITIONS
<i>Erbium</i> , Er Er (Curzon and Chlebek, 1972)	Erbium vacuum-evaporated onto carbon films or rock-salt substrates mounted on glass slides. The films were floated off the glass substrates onto water	
<i>Iron</i> , Fe Ferrous materials (Irani and Jones, 1966)	<i>Electrothin</i> : 75 % hydrochloric acid 25 % water <i>Electropolish</i> (classical 'chrome-acetic' electrolyte): 133ml glacial acetic acid 25g chromium trioxide 7ml water	10 V
Fe (Dingley and Hale, 1966)	<i>Electropolish</i> : 5 % perchloric acid 95 % acetic acid	35–45 V, < 30°C stainless steel cathode wash in methanol
Fe (Adair et al., 1966)	<i>Electropolish</i> : 20 % perchloric acid 80 % ethanol	18 V
Fe (Smidt and Mastel, 1969)	<i>Electropolish</i> : 20 parts perchloric acid 100 parts ethanol	12 V, 0.1 A/cm ²
Fe–AlN (Furubayashi et al., 1974)	<i>Chemical polish</i> : 8 % hydrofluoric acid 92 % hydrogen peroxide	Room temp.
Fe–Al alloys (Swann et al. 1972)	<i>Electrothin</i> : 10 % perchloric acid 90 % ethanol <i>Jet polish</i> : 180g sodium chromate 900ml acetic acid	18 V, 0°C window method
Fe–7%Al–C (Watanabe and Wayman, 1971)	<i>Chemical</i> : 1 part hydrofluoric acid 3 parts water 16 parts hydrogen peroxide <i>Electropolish</i> : 100g chromium trioxide 200ml phosphoric acid	
Fe–C (Marder 1969)	<i>Chemical</i> : 5 % hydrofluoric acid 15 % water 80 % hydrogen peroxide	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	<i>Electropolish:</i> 77.7% acetic acid 7.5% chromium trioxide 15% sodium oxalate	To prevent etching-out of finely dispersed precipitates, one side of foil was coated with lacquer and polishing continued from the other side
Fe-C (Morgan et al., 1966)	<i>Jet:</i> 31% acetic acid 23% orthophosphoric acid 15% nitric acid 31% water plus a few drops of detergent	50 V, room temp.
	<i>Electropolish:</i> 90% acetic acid 10% perchloric acid	25 V, room temp.
Fe-C martensites (Vyhnal and Radcliffe, 1967)	<i>Jet:</i> 10% perchloric acid 90% acetic acid	100 V, 25 mA
	<i>Electropolish:</i> 100g anhydrous sodium chromate 500ml acetic acid	30-35 V 50-80 mA, room temp.
Fe-C-N alloys (Phillips 1963)	<i>Electropolish:</i> 700 parts ethanol 137 parts water 62 parts perchloric acid just before use add: 100 parts butyl cellulolve	40 V wash in alcohol
Many steels (Schoone and Fischione, 1966)	<i>Jet polish:</i> 100g sodium chromate 500ml acetic acid Authors describe a double-jet polishing apparatus with automatic shut-off	30-35 V
Mild steel (Ginn and Brown, 1965)	<i>Electropolish:</i> 95% acetic acid 5% water 400g/l chromium trioxide	1-3 V
Many steels and Fe (Bryner and Chow, 1970; Glenn and Raley, 1963)	<i>Electropolish:</i> 96% acetic acid 4% water 200g/l chromium trioxide	10 V, 0-20°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	Stir at 65°C for 1 h. Cool. Rinse specimen in alcohol, but dip in acetic acid to remove oxidation products from surface before replacing in electrolyte	
Iron-based alloys (Davenport and Belyakov, 1968)	<i>Electropolish:</i> 1 % perchloric acid 99 % methanol Specimens washed in successive baths of ethanol	30–50 V, –70°C 18/8 steel cathode
Carbon and low-alloy steels (Keown and Pickering, 1962)	<i>Chemical polish:</i> 50 % water 40 % nitric acid 10 % hydrofluoric acid	
Low-alloy steels (Davy et al., 1966)	<i>Chemical polish:</i> 5ml sulphuric acid 8g oxalic acid 100ml water Solution mixed with equal volume of hydrogen peroxide (100 %). At temperatures exceeding 35–40°C, decomposition of hydrogen peroxide occurs	
Steel wires (Glenn and Duff, 1965)	<i>Electropolish:</i> 20 % anhydrous sodium chromate 80 % acetic acid Wires embedded in plated nickel and electropolished	40 V, 20°C
Austenitic stainless steels (Pumphrey and Edington, 1974)	<i>Jet:</i> 10 % nitric acid 90 % water <i>Electropolish:</i> 10 % perchloric acid 20 % glycerol 70 % ethanol	50 V 65 V
Austenitic stainless steels (Spruiell et al., 1973)	<i>Jet:</i> 60 % orthophosphoric acid 40 % sulphuric acid <i>Electropolish:</i> 6 % perchloric acid 94 % ethanol	100°C
Bainitic and martensitic steels (Irani and Jones, 1966)	<i>Electropolish:</i> 5 % perchloric acid 95 % acetic anhydride Perchloric acid must be added slowly and bath	< 20°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	stirred constantly. Temperature must be maintained below 20°C using an iced bath	
Fe–20Cr–25Ni alloy (Jones and Ralph, 1975)	<i>Jet polish:</i> 2% perchloric acid 98% 2-butoxyethanol	
Chromium steels (Davy et al., 1966)	<i>Chemical polish:</i> 20ml glycerol 20ml hydrogen peroxide (100%) 20ml water 10ml hydrochloric acid Solution must be freshly prepared	
Eutectoid steels (Bly et al., 1973)	<i>Jet polish:</i> 5% perchloric acid 95% acetic acid	24 V, room temp.
Hadfields' manganese steel (Raghavan et al., 1969)	<i>Electropolish:</i> 3% perchloric acid 97% methanol	–78°C (dry ice and acetone)
Hadfield steel, Fe–Mn–C (Roberts, 1964)	<i>Chemical:</i> 50% water 40% nitric acid 10% hydrofluoric acid <i>Jet:</i> 20% hydrochloric acid 80% water <i>Electropolish:</i> 100g chromium trioxide 100ml water 250ml orthophosphoric acid	6 V, 65°C
Maraging steels (Wirth and Bickerstaffe, 1974)	<i>Chemical:</i> 40% hydrogen peroxide (100 vol.) 8% hydrofluoric acid 8% hydrochloric acid 44% water <i>Jet:</i> 20% perchloric acid 80% methanol <i>Electropolish:</i> 1% perchloric acid 99% methanol <i>or</i> 10% perchloric acid 90% methanol	20°C, 30 s –70°C –10°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Martensitic alloys (Lindborg and Averbach, 1966)	<i>Chemical:</i> 1.1 part orthophosphoric acid 1 part hydrogen peroxide <i>Electropolish:</i> 133ml acetic acid 25g chromium trioxide 7ml water	
Low-carbon martensites (Speich and Warlimont, 1968)	<i>Electropolish:</i> 810ml acetic acid 150g chromium trioxide 42ml water	
Austenitic/martensitic alloys (Morton and Wayman, 1966)	<i>Electrothin:</i> orthophosphoric acid saturated with chromium trioxide <i>Electropolish:</i> 133ml acetic acid 25g chromium trioxide 7ml water	60°C 10°C
Pearlitic steels (Davy et al., 1966)	<i>Electropolish:</i> 133ml acetic acid 7ml water 25g chromium trioxide 2ml sulphuric acid	12–30 V stainless steel cathode
Other steels (Davy et al., 1966)	<i>Electropolish:</i> 10ml perchloric acid 100ml acetic acid	9–12 V stainless steel cathode
Stainless steel (Michel et al., 1973)	<i>Jet polish:</i> 10% perchloric acid 90% acetic acid	Twin-jet technique
Stainless steel (McDonald and Ardell, 1973)	<i>Electropolish:</i> 10% perchloric acid 90% ethanol	12 V, 0°C
Stainless steel (Fawley et al., 1968)	<i>Electropolish:</i> 10% perchloric acid 90% acetic acid	20 V disc specimens
Stainless and high-alloy steels (Keown and Pickering, 1962)	<i>Chemical polish:</i> 45% water 30% nitric acid 10% hydrofluoric acid 15% hydrochloric acid	
Stainless steel (Barnby, 1966 and 1967)	<i>Jet:</i> 10% nitric acid 90% water	90 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	<i>Electrothin:</i> 5% perchloric acid 95% acetic anhydride	
	<i>Electropolish:</i> 14g metabenzene-disulphonic acid 1.5g oxalic acid 1.5g picric acid 75ml ethylene glycol	10 V
Stainless steel (Rowcliffe, 1966)	<i>Jet:</i> 48% orthophosphoric acid 32% sulphuric acid 20% water	
	<i>Electropolish:</i> 54% orthophosphoric acid 36% sulphuric acid 10% ethanol or water	
Stainless steel (Holmes et al., 1968)	<i>Electropolish:</i> 40% sulphuric acid 60% phosphoric acid	35 V, 0.3 A/cm ²
Fe-Co-V (Davies and Stoloff, 1966)	<i>Electropolish:</i> 25g chromium trioxide 133ml acetic acid 7ml water	
Fe-Cr-C alloys (Campbell and Honeycombe, 1974)	<i>Chemical:</i> 30% nitric acid 10% hydrofluoric acid 15% hydrochloric acid 45% water	65°C
	<i>Electropolish:</i> 50g chromium trioxide 14ml water 250ml acetic acid	25-30 V, 15°C
Low-chromium hyper-eutectoid steels (Wilson and Owen, 1965)	<i>Chemical:</i> 33% nitric acid 67% acetic acid	
	<i>Electropolish:</i> 9% perchloric acid 91% acetic acid	30 V, 0.2 A/cm ² wash specimen in water and dry
Cr steels (Srinivasan and Wayman, 1968)	<i>Chemical:</i> 50% hydrogen peroxide (30%) 50% orthophosphoric acid (70%)	50°C
	<i>Electropolish:</i> 150g chromium trioxide 750ml acetic acid 30ml water	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Fe–Cr system (Pascover and Radcliffe, 1969)	<i>Jet:</i> 10% perchloric acid 90% acetic acid <i>Electropolish:</i> 5% perchloric acid 95% acetic acid <i>or</i> 1g anhydrous sodium chromate 5ml acetic acid	Room temp. 27 V 20–35 V room temp.
12%Cr steels (Hede and Aronsson, 1969)	<i>Electrothin:</i> 40% sulphuric acid 60% orthophosphoric acid <i>Electropolish:</i> 100g chromium trioxide 540ml acetic acid 25ml water	
Fe–21%Cr (Blackburn and Nutting, 1964)	<i>Electropolish:</i> 50g chromium trioxide 238ml methanol 7ml water	
Fe–Cr–C–Co steels (Raghavan and Thomas, 1971)	<i>Electropolish:</i> 75g chromium trioxide 20ml water 400ml acetic acid	19–25 V
1%Cr–Mo–V steels (Buchi et al., 1965)	<i>Electropolish:</i> 8% perchloric acid 92% acetic acid	55 V
Cr–Ni austenitic steels (van Aswegen et al., 1964)	<i>Electropolish:</i> 5% perchloric acid 95% acetic anhydride	20 V, 0.1 A/cm ² , < 15°C
Fe–Cr–Ni alloys (Breedis, 1964)	<i>Electropolish:</i> 25g chromium trioxide 133ml acetic acid 7ml water	20°C discs first dimpled by jetting
18Cr–10Ni steel containing phosphorus (Rowcliffe and Nicholson, 1972)	<i>Jet:</i> 50% orthophosphoric acid 35% sulphuric acid 15% water <i>Electropolish:</i> 70% ethanol 20% glycerol 10% perchloric acid	p.t.f.e. holder –10°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
17 %Cr–11 %Ni–2.5 %Mo–Fe (type 316 steel) (Mazza and Willoughby, 1966)	<i>Jet:</i> 10 % nitric acid 90 % water <i>Electrothin:</i> perchloric acid acetic anhydride <i>Electropolish</i> (Garofalo solution): 14g metabenzene-disulphonic acid 1.5g oxalic acid 1.5g picric acid 75ml ethanediol	100 V
18Cr–8Ni stainless steel (Thomas and Krauss, 1967)	<i>Electrothin:</i> 5 % perchloric acid 95 % acetic acid <i>Electropolish:</i> 133ml acetic acid 25g chromium trioxide 7ml water	
18Cr–8Ni steels (Lagneborg, 1964)	<i>Electropolish:</i> 35 % perchloric acid 62 % acetic acid 3 % water	
Cr–Ni–Nb steel (Ramaswamy et al., 1968)	<i>Jet:</i> 40 % acetic acid 30 % orthophosphoric acid 20 % nitric acid 10 % water <i>Electropolish:</i> 54 % orthophosphoric acid 36 % sulphuric acid 10 % ethanol	80–120 V, 0.1 A/cm ² 6 V
18Cr–25Ni–Nb steel (Naybour, 1965)	<i>Electropolish:</i> 10 % perchloric acid 20 % glycerol 70 % methanol	
20Cr–25Ni–Nb steel (Francis and Whitlow, 1965)	<i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid	0.3 A/cm ² , 20–30°C
Fe–Cr–Nb alloys (Vowles and West, 1973)	<i>Jet:</i> 37 % hydrochloric acid 63 % water <i>Electropolish:</i> saturated solution of chromium trioxide in orthophosphoric acid	50 V 12 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Fe–Cu (Duggan and Roberts, 1973)	<i>Chemical:</i> 50 % oxalic acid (8 % soln. in water) 50 % hydrogen peroxide (100 vol.) few drops of sulphuric acid <i>Electropolish:</i> 1 part perchloric acid 10 parts acetic acid	37.5 V, 20°C constant agitation
Cu steels (Cox, 1967 and 1969)	<i>Electrothin:</i> 5 % perchloric acid 95 % acetic acid <i>Electropolish:</i> 135ml acetic acid 7ml water 25g chromium trioxide	40 V, 20°C 18 V, < 20°C
Fe–Mn (Echigoya, 1973)	<i>Chemical polish:</i> 85ml hydrogen peroxide 10ml water 5ml hydrofluoric acid 5ml nitric acid	
Fe–Mn alloys (Roberts, 1970)	<i>Electropolish:</i> 15 % sodium chromate 7.5 % chromium trioxide 77.5 % acetic acid	
Fe–Mn–C with carbide-forming elements (Drobnjak and Parr, 1970)	<i>Chemical:</i> 50 % water 40 % nitric acid 10 % hydrofluoric acid <i>Electrothin:</i> 10 % perchloric acid 90 % acetic acid <i>Electropolish:</i> 500ml acetic acid 100g sodium chromate	15–20 V 30–40 V
Fe–Mn–N alloys (Baird, 1966)	<i>Chemical:</i> 10 % hydrofluoric acid 66 % nitric acid 24 % water <i>Electropolish:</i> 5 % perchloric acid 95 % acetic acid	
Fe–Mo–C (Edmonds and Honeycombe, 1973)	<i>Chemical:</i> 50ml hydrogen peroxide 50ml water 7ml hydrofluoric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Fe–Ni alloys (Shapiro and Krauss, 1966 and 1967)	<i>Electropolish:</i> 1 % perchloric acid 99 % methanol	50 V, –70°C
	<i>Chemical (for carbon and low-alloy steels):</i> 50 % water 40 % nitric acid 10 % hydrofluoric acid	
	<i>Chemical (for stainless and high-alloy steels):</i> 45 % water 30 % nitric acid 10 % hydrofluoric acid 15 % hydrochloric acid	
Fe–Ni martensites (Patrician et al., 1972)	<i>Electropolish:</i> 135ml acetic acid 25g chromium trioxide 7ml water	25–30 V
	<i>Chemical polish:</i> 80ml hydrogen peroxide 5ml hydrofluoric acid 15ml water	70°C
Fe–Ni (Hammond and Ansell, 1964)	<i>Electropolish:</i> 6 % sulphuric acid 94 % orthophosphoric acid 100g/l chromium trioxide	0.33 A/cm ² , 60°C
Fe–Ni (Jana and Wayman, 1967)	<i>Chemical:</i> 50 % hydrogen peroxide (30 %) 50 % orthophosphoric acid (70 %)	
	<i>Electropolish:</i> 150g chromium trioxide 750ml acetic acid 30ml water	
Fe–32 %Ni (Rowlands et al., 1970)	<i>Electropolish:</i> 9 % perchloric acid 91 % acetic acid	Single crystals
Fe–32.3 %Ni (Dash and Brown, 1966)	<i>Electrothin:</i> 100 parts acetic acid 10 parts perchloric acid washed in water and methanol	20 V, 0.3 A/cm ² 5–10°C
	<i>Electropolish:</i> 133ml acetic acid 25g chromium trioxide 7ml water	22 V, 0.05 A/cm ² , 5°C
Fe–33 %Ni (Krauss, 1963)	<i>Electropolish:</i> 5 % perchloric acid 95 % acetic acid	40 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Fe–Ni–C alloy (Habrovec et al., 1967)	<i>Electropolish:</i> 35ml acetic acid 2.4ml water 8.5g chromium trioxide	
Fe–Ni–C (Kounicky, 1968)	<i>Chemical:</i> 14 parts hydrogen peroxide 1 part hydrofluoric acid <i>Electropolish:</i> 100g chromium trioxide 200ml orthophosphoric acid	< 20 V, 60°C
Fe–Ni–Cr (Hays and Nail, 1974)	<i>Electrothin:</i> 1 part sulphuric acid 7 parts methanol <i>Electropolish:</i> 150g anhydrous sodium chromate 750ml glacial acetic acid	10 V, wash in methanol, dry thoroughly 25 V
Fe–Ni–Cr alloys (Benson et al., 1968)	<i>Electropolish:</i> 45 % orthophosphoric acid 30 % sulphuric acid 25 % water	6 V
18 %Ni–Co–Mo maraging steels (Miller and Mitchell, 1965)	<i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid	
18 %Ni maraging steel (Parkins and Haney, 1968)	<i>Electrothin:</i> 50 % hydrochloric acid 50 % water <i>Electropolish:</i> 450g sodium chromate 3l acetic acid	10 A 70 V, 0.56 A
25 %Ni–Ti–Al maraging steel (Garwood and Jones, 1966)	<i>Chemical:</i> 10 % hydrofluoric acid 15 % hydrochloric acid 30 % nitric acid 45 % water <i>Electropolish:</i> 135ml acetic acid 25g chromium trioxide 7ml water	
Fe–Ni–Sn (Nissan and Hornstein, 1974)	<i>Electropolish:</i> 4 % perchloric acid 76 % acetic acid 20 % ethanol	30–35 V, < 10°C rinse in water, then methanol

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Fe–Ni–V–C (Apple and Krauss, 1971)	<i>Chemical:</i> 16 parts hydrogen peroxide 3 parts water 1 part hydrofluoric acid <i>Jet polish:</i> 755ml acetic acid 150g sodium chromate 75g chromium trioxide	
Nitrided iron alloy and steels (Phillips and Seybolt, 1968)	<i>Jet polish:</i> 10% perchloric acid 90% glacial acetic acid Single-jet electrothinning technique. Specimens thinned 2/3 through, carbon evaporated on one side, then sample thinned from other side until hole appears	150 V, 10°C
Fe + nitrides (Hrivňák, 1966)	<i>Chemical:</i> acetic acid hydrochloric acid water hydrogen peroxide <i>Electropolish:</i> 133ml acetic acid 25g chromium trioxide 7ml water	
Low- and high-nitrogen martensites (Biswas and Codd, 1968)	Lengthy thinning procedures fully described	
Fe ₃ O ₄ (Wickes, 1968)	<i>Chemical polish:</i> 80% orthophosphoric acid 20% water	120°C
Magnetic iron oxides (Schmidt et al., 1970)	Ion bombardment	6 kV, 120μA, argon ions
Fe–Pt (Kajiwara and Owen, 1974)	<i>Electropolish:</i> 60% orthophosphoric acid 40% sulphuric acid	20–35 V, 20°C
Fe–Si stainless steel (Tomlinson, 1958)	<i>Electropolish:</i> 60% orthophosphoric acid 40% sulphuric acid	9 V, approx. 60°C stainless steel cathode
Fe–Si (Gemperle, 1963)	<i>Electropolish:</i> 80% orthophosphoric acid 13% chromium trioxide 7% water	8 V single crystals
Fe–Si (Walter and Koch, 1962 and 1965)	<i>Chemical:</i> 1 part nitric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	1 part hydrofluoric acid 1.5 parts water	
	<i>Electropolish:</i> Disapol AC-1, (AC-2 or D-2)*	
Fe-Si alloys (Aronsson and Grånäs, 1971)	<i>Electropolish:</i> 540ml acetic acid 100g chromium trioxide 25ml water	
Fe-3 %Si (Griffiths and Riley, 1966)	<i>Electrothin:</i> 60 % phosphoric acid 40 % sulphuric acid	
	<i>Electropolish:</i> 8 % perchloric acid 92 % acetic acid	
Fe-4.4 %Si crystals (Takeuchi et al., 1967)	<i>Chemical:</i> 100ml hydrogen peroxide 5ml hydrofluoric acid	
	<i>Electropolish:</i> orthophosphoric acid saturated with chromium trioxide	80°C
Fe-13at. %Si (Saburi and Neuno, 1967)	<i>Chemical:</i> 10 % hydrofluoric acid 90 % hydrogen peroxide	
	<i>Electropolish:</i> 80 % acetic acid 20 % perchloric acid	approx. 5°C
FeSi ₂ (Matthes et al., 1970)	<i>Chemical polish:</i> 30 % nitric acid 10 % hydrofluoric acid 15 % hydrochloric acid 45 % water	
	Discs cut by ultrasonic drill and lapped to 200µm thickness before chemical polishing	
Fe ₃ Si (Lakso and Marcinkowski, 1969)	<i>Electropolish:</i> 0.1 % perchloric acid 2.5 % hydrofluoric acid 97.4 % methanol	-77°C
Fe-Si-Ti (Watson and Brown, 1974)	<i>Chemical:</i> 5 % hydrofluoric acid 95 % hydrogen peroxide	
	<i>Electropolish:</i> 5 % perchloric acid 95 % butoxyethanol	-10 to -20°C

* Disapol is the registered trademark of Struers Scientific Instruments, Copenhagen, Denmark.

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Fe ₇ S ₈ pyrrhotite (van Landuyt and Amelinckx, 1972)	Ion bombardment of crystal slices	
Fe-Ti (Rack and Cohen, 1970)	<i>Jet:</i> 95 % acetic acid 5 % perchloric acid	12 V, 20°C
	<i>Jet polish:</i> 150ml methanol 87ml <i>n</i> -butyl alcohol 15ml perchloric acid	15 V, < -50°C
Fe-V (Baker, 1973)	<i>Chemical:</i> 50 % hydrogen peroxide (100 vol.) 50 % water 7 % hydrofluoric acid (60 % w/w)	
	<i>Electropolish:</i> 70 % ethyl alcohol 20 % glycerol 10 % perchloric acid (1.7 s.g.)	16 V, -10°C
Fe-W (Abrahamson and Dumais, 1966)	<i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid	
<i>Particular precipitates in steels</i>		
Ti steels (M ₂₃ C ₆) (Singhal and Martin, 1967a and b; 1968)	<i>Jet:</i> 15 % hydrochloric acid 15 % water	80 V
	<i>Electropolish:</i> 10 % perchloric acid 20 % glycerol 70 % ethanol	10 V, 0.3 A/cm ² , 0-5°C
M ₂₃ C ₆ carbide in austenite (Beckitt and Clark, 1967)	<i>Chemical:</i> 10 % hydrofluoric acid 40 % nitric acid 50 % water	
	<i>Electropolish:</i> 10 % perchloric acid 1 % nitric acid 89 % acetic acid	
Mo ₂ C in ferrite (Dyson et al., 1966)	<i>Chemical:</i> 40 % nitric acid 10 % hydrofluoric acid 50 % water	
	<i>Electropolish:</i> 5 % perchloric acid 95 % acetic anhydride	
	or	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	saturated solution of chromium trioxide in orthophosphoric acid	
NbC in stainless steel (Silcock and Tunstall, 1964)	<i>Jet:</i> 10% nitric acid 90% water	50 V
	<i>Electropolish:</i> 10% perchloric acid 20% glycerol 70% ethanol	11–12 V, room temp. platinum cathode
NbC in steel (Deighton, 1967)	<i>Electropolish:</i> 60% orthophosphoric acid 40% sulphuric acid	9 V, 70°C
σ -phase of Fe–Cr–Mo–Ti (Meulemans et al., 1970)	<i>Electropolish:</i> 10% perchloric acid 90% acetic acid	
σ -phase in austenite (Duhaj et al., 1968)	<i>Chemical:</i> 45% water 30% nitric acid 10% hydrofluoric acid 15% hydrochloric acid	
	<i>Electropolish:</i> 90% acetic acid 5% ethanol 5% perchloric acid	
TiC particles in steel (Ozel and Nutting, 1969)	<i>Electropolish:</i> 10% perchloric acid 90% acetic acid plus small additions of nickel chloride and chromium trioxide	
Gadolinium, Gd Gd–Ce alloys (Koch et al., 1971)	<i>Electropolish:</i> 1% perchloric acid 99% methanol	–77°C
Gd ₂ (MoO ₄) ₃ (Yamamoto et al., 1974)	<i>Chemical polish:</i> hot phosphoric acid	
Gallium, Ga GaAs (Narayanan and Copley, 1974)	<i>Chemical jet polish:</i> 40 parts hydrochloric acid 4 parts hydrogen peroxide 1 part water	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	Orange to yellow light can be transmitted when specimen is electron transparent. Rinse thoroughly in distilled water	
GaAs (Hill et al., 1968)	<i>Chemical jet polish:</i> 88 % hydrochloric acid 10 % hydrogen peroxide 2 % water	
GaAs (Holt et al., 1966)	<i>Chemical jet polish:</i> aqueous solution of sodium hypochlorite with 1 % available chlorine	
GaAs (Buiocchi, 1967)	<i>Chemical polish:</i> 1–4 % bromine in methanol	Rotating beaker technique
	or	
	42 % nitric acid 14 % hydrofluoric acid 7 % hydrochloric acid 37 % water	
GaP (Gai and Howie, 1974)	<i>Chemical:</i> immerse discs for 2 min in bromine-activated methanol <i>Chemical polish:</i> immersion in warm aqua regia	
GaP–GaAsP (Holt et al., 1966)	<i>Chemical jet polish:</i> 50 % hydrochloric acid 50 % nitric acid	
Germanium, Ge Ge (Lake et al., 1974)	<i>Chemical:</i> 15 parts hydrofluoric acid 25 parts nitric acid 15 parts acetic acid 0.3 parts bromine <i>Jet polish:</i> 0.05 molar potassium hydroxide	2 min
Ge (Ferreira-Lima and Warminski, 1973)	<i>Electropolish:</i> 0.05 normal potassium hydroxide Specimen must be thoroughly washed in distilled water for several minutes immediately after polishing. Solution must be used for several hours before it gives a suitable polish	
Ge–Si (Herd et al., 1972)	Amorphous films vacuum deposited on rock salt substrate. Substrate dissolved in water, and	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	films collected on Mo or W grids before examination in hot stage of microscope	
α -Ge (Barna et al., 1972)	Thin films deposited and heat treated in the electron microscope. Details in paper	
Ge (Merli and Valdré, 1972)	<i>Chemical jet polish:</i> 85% nitric acid 15% hydrofluoric acid (48%)	
Ge (Schaumburg, 1972; Parsons et al., 1970)	<i>Chemical jet polish:</i> 90% nitric acid 10% hydrofluoric acid	
	or	
	dilute sodium hypochlorite solution (1% w/v available chlorine)	30–40°C
Ge (Phillips and Hugo, 1970)	<i>Chemical jet polish:</i> 90% nitric acid 10% hydrofluoric acid	55°C wash in water
Ge (den Ouden, 1969)	<i>Chemical polish:</i> 17% hydrofluoric acid 17% hydrogen peroxide 66% water	30°C wash in ethanol
Ge (Holt and Danger, 1963)	<i>Electropolish:</i> 1 part acetic acid 1 part nitric acid 1 part hydrofluoric acid (38–40%) plus 1 drop of bromine to each 30ml of solution	35°C p.t.f.e. holder
CdS on Ge substrate (Abdalla et al., 1973)	Substrate thinned from back by <i>Jet polish:</i> 35g potassium hydroxide 3g ammonium chloride 2000ml de-ionised water	
Gold, Au Au (Bapna et al., 1968; Eades, 1969)	<i>Jet:</i> 35% ethyl alcohol 15% glycerine 50% hydrochloric acid (conc.) <i>Electropolish:</i> 14.17g potassium cyanide 3.15g Rochelle salt 3.15g potassium ferrocyanide 3.45ml ammonia 3.75ml phosphoric acid 210ml water	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Au (Shimonura, 1969)	<i>Electropolish:</i> 30% ethanol 50% hydrochloric acid 10% glycerol	18 V, – 50°C wash in water and ethanol
Au (Grosskreutz, 1965)	<i>Electropolish:</i> 133ml acetic acid 25g chromium trioxide 7ml water Foil cleaned before examination in: 50% sulphuric acid 50% nitric acid saturated with chromium trioxide	20°C
Au (Segall and Clarebrough, 1964)	<i>Electropolish:</i> 17g potassium cyanide 3.75g potassium ferrocyanide 3.75g potassium sodium tartrate 3.5ml phosphoric acid 1ml ammonia 250ml water	0°C and above wash in water
Au, Au–Cd, Au–Zn (Quader and Dodd, 1968)	<i>Electropolish:</i> 17g potassium cyanide 3.75g potassium ferrocyanide 3.75g potassium sodium tartrate 1ml ammonium hydroxide 250ml water	6 V, 35–40°C stainless steel cathode
Au–Co (Clipstone and Gaunt, 1969)	<i>Electropolish:</i> 5% potassium iodide 95% water	Platinum cathode
AuCu (Hansson and Barnes, 1964)	<i>Electropolish:</i> 25% perchloric acid 75% acetic acid	
AuCu ₃ (Fisher and Marcinkowski, 1961)	<i>Electropolish:</i> 25g chromium trioxide 133ml acetic acid 7ml water	25 V, 22°C stainless steel cathodes
Au–Fe (two-phase) (Roberge and Leak, 1973)	Ar ion bombardment	
Au–Mn and Au–Cr alloys (Tanner et al., 1968)	Vapour-deposited single-crystal thin films	
Au–Ni alloys (Woodilla and Averbach, 1968 and 1970)	<i>Jet:</i> 30% nitric acid 70% water	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	<i>Electropolish:</i> < 54at. %Ni: 35g chromium trioxide 210ml acetic acid 10ml water > 54at. %Ni: 53ml perchloric acid 177ml acetic acid	
Au-SiO (McMaster and Fuschillo, 1970)	Amorphous films vacuum deposited. Studied in heating stage	
Au-53.9at. %Zn (Ball and Smallman, 1965)	<i>Electropolish:</i> 25g chromium trioxide 133ml acetic acid 7ml water	
β -AuZn (Schulson and Teghtsoonian, 1969)	<i>Electropolish:</i> 50 % ethanol 45 % hydrochloric acid 5 % glycerin	12 V, -20°C single-crystal disc specimens
<i>Hafnium, Hf:</i> Hf single crystals (Das and Mitchell, 1973)	<i>Chemical jet:</i> 45 parts nitric acid 45 parts water 8 parts hydrofluoric acid <i>Electropolish:</i> 2 % perchloric acid 98 % ethanol	40-45 V, 16-20 mA dry ice and acetone bath
Hf (Vahldiek, 1969)	<i>Electropolish:</i> perchloric acid acetic acid	47 V
<i>Indium, In</i> In (Remaut et al., 1964)	<i>Electropolish:</i> 33 % nitric acid 67 % methanol	
In (Singh and Murr, 1972a and b)	Thin film vapour deposited onto cleaved rock salt. Then a carbon film was evaporated on top and the two films floated off on water onto 200-mesh grids	
InSb (Holt et al., 1966)	<i>Chemical jet polish:</i> 5g/l chromium trioxide in hydrochloric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
InSb (Eckenbach et al., 1971)	Layer of amorphous InSb was flash evaporated onto a thin film of Formvar which was fixed on a copper grid	
<i>Iridium</i> , Ir Ir (Zeilinski and Sikka, 1973)	<i>Electropolish:</i> 103ml calcium chloride (density 1.45g/cm ³) 73ml water 6ml hydrochloric acid (conc.)	30V r.m.s. at 60Hz; -40°C large Ir cathode; stir
Ir (Murr, 1974)	<i>Electrothin:</i> 2 normal potassium cyanide	10-12 V a.c. room temp. stainless steel cathode
	When holes begin to form: <i>Electropolish:</i> conc. nitric acid	1 min at 10 V a.c., room temp. stainless steel cathode
	Final rinse in ethyl alcohol	
Ir (Gath et al., 1969)	<i>Jet polish:</i> saturated aqueous solution of calcium chloride. For annealed specimens add 0.5% hydrochloric acid	20-100 V a.c.
<i>Lanthanum</i> , La La (Marcinkowski and Hopkins, 1968)	<i>Electropolish:</i> 3% perchloric acid 97% methanol Cooled with a dry ice and acetone bath	
<i>Lead</i> , Pb Pb (Urban and Seeger, 1974)	<i>Chemical polish:</i> 20% hydrogen peroxide 80% acetic acid	Room temp.
PbAl ₁₂ O ₁₉ (Comer, 1967)	Bulk material ground in amyl acetate using mortar and pestle. Suspension deposited on holey carbon substrate grids	
PbS (Kirkwood and Nutting, 1965)	Thin films prepared by passing H ₂ S over a saturated solution of lead nitrate in water. A silvery film was formed on the solution surface.	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	This was transferred by a gauze to a bath of distilled water and washed. Pieces of film were caught on grids and dried	
<i>Lithium, Li</i>		
Li (Sass, 1969)	Freshly cut surface is shaved with a razor blade in a dry, inert atmosphere	
Li (Petroff and Jouffrey, 1969)	<i>Chemical polish:</i> 50 % methanol 50 % xylene	Inert atmosphere
Li (oxide/fluoride) (Russell et al., 1970)	Li evaporated onto carbon substrate	
LiFe ₅ O ₈ (van der Biest and Thomas, 1974)	<i>Chemical polish:</i> thin slice of crystal allowed to dissolve in hot phosphoric acid ($\pm 250^{\circ}\text{C}$) until edges are electron transparent <i>and/or</i> ion bombardment	
Lithium ferrites (Allpress, 1971)	Sintered material ground in agate mortar. Thin edges viewed in transmission	
LiF–MgF ₂ (Bright and Lewis, 1971a)	Rods of MgF ₂ in LiF matrix. 1. Rods extracted using dilute ammonia solution 2. Cleaved fragments from bulk viewed through thin edges	
<i>Magnesium, Mg</i>		
Mg (Hampshire and Hardie, 1974)	<i>Electropolish:</i> 20 % nitric acid 80 % methyl alcohol	2 V, room temp. wash immediately in methanol and dry
Mg (Stevenson and Vander Sande, 1974)	<i>Electropolish:</i> 6 % nitric acid 94 % water	3°C
Mg (Obara et al., 1973)	<i>Chemical jet polish:</i> 25 % nitric acid 75 % ethanol	
Mg (Buchanan and Reed-Hill, 1969a and b)	<i>Jet:</i> 20 % perchloric acid 80 % ethanol <i>Electropolish:</i> 10 % perchloric acid	–50°C –50°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	90 % ethanol Rinse in three separate ethanol baths, to avoid staining	
Mg (Tsui, 1967)	<i>Electropolish:</i> 20 % nitric acid 80 % methyl alcohol	8–10 V, 1 A/cm ² , 0°C
	Specimens too small for window technique were immersed half way and electropolished. They were then turned upside down with the centre portion overlapping and polishing continued until just a thin ribbon was left.	
Mg (Lally and Partridge, 1966; Harris and Masters, 1966)	<i>Chemical polish:</i> 5–15 % nitric acid in water Higher acid concentrations for smaller specimens. Wash in methanol and dry quickly to avoid oxide layer	
Mg–Ag (Stickler and Engle, 1963)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	10 V, cool
Mg–Al alloys (Crawley and Milliken, 1974)	<i>Chemical:</i> 80 % orthophosphoric acid 20 % ethanol <i>Electropolish:</i> 1 % perchloric acid 99 % ethanol	30–50 V, –55°C stainless steel cathode
Mg–9wt.%Al (Clark, 1968)	<i>Chemical polish</i> (low precipitate content): 1 part nitric acid 2 parts methanol <i>Chemical polish</i> (high precipitate content): orthophosphoric acid 1. Rinse in ethanol (stirred) 2. Dip rinse in 20g anhydrous citric acid dissolved in 500ml ethanol 3. Rinse in ethanol	20–80°C, stirred
MgAl ₂ O ₄ spinel (Lewis, 1966a)	Crystal slice first ultrasonically drilled to produce a flat-bottomed depression in one face <i>Chemical polish:</i> Crystal then held by platinum grips and dipped in orthophosphoric acid in a platinum crucible. Polishing temperatures: {100} > 250°C {110} > 350°C {111} > 450°C Wash in boiling water, then ethanol	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Mg ₃ Cd (Blackburn, 1967)	<i>Electropolish:</i> 50ml nitric acid 180ml methanol	10 V, -40°C
Mg-10.5at. %Li (Urakami et al., 1970)	<i>Jet:</i> nitric acid ethanol Final polishing by immersion in same solution until perforation occurs	10°C
Mg-γ-(MgAl) (Livingston et al., 1970)	<i>Electropolish:</i> 80% ethanol 20% perchloric acid	
Mg-Mn (de Luca and Byrne, 1965)	<i>Electropolish:</i> 32.5% orthophosphoric acid 67.5% ethanol	3 V for 30s to remove oxide layer; continue polishing with 1.5 V. Wash in a series of water baths, then rinse in ethanol and dry
Mg-Nd (Pike and Noble, 1973)	<i>Electropolish:</i> 30% nitric acid 70% ethanol	
MgO (Hüther and Reppich, 1973)	<i>Chemical polish:</i> hot orthophosphoric acid	
MgO (Narayan, 1973)	<i>Chemical polish:</i> cleaved sections chemically polished in 85% orthophosphoric acid at 150-160°C to remove surface damage. Sections then etched to reveal sub-boundaries in soln. of 5 parts saturated ammonium chloride, 1 part sulphuric acid and 1 part distilled water at room temp. for 15 min. Desired area then thinned in a jet of hot orthophosphoric acid	
MgO (Bilde-Sørensen, 1972)	<i>Chemical polish:</i> 79% orthophosphoric acid (1.75g/ml) 20% water 1% sulphuric acid (1.84g/ml)	135°C
MgO (Lewis, 1966; Ogawa, 1966)	<i>Chemical polish:</i> orthophosphoric acid Wash thoroughly in water, methanol and ethyl ether	110°C
MgO (Stokes, 1966)	<i>Chemical polish:</i> orthophosphoric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	2–5 % sulphuric acid	
MgO (Cass and Washburn, 1966)	<i>Chemical polish:</i> orthophosphoric acid	150–160°C
Mg–Th–Zr alloy (Mushovic and Stoloff, 1969)	<i>Electropolish:</i> 80 % ethanol 20 % perchloric acid Specimens rinsed in water, then methanol, and dried between filter papers	10–15 V, 0°C
Mg–5wt. %Zn (Clark, 1965)	<i>Electropolish:</i> 60 % methanol 30 % glycerin 10 % nitric acid <i>or</i> <i>Chemical polish:</i> I 650ml methanol 300ml water 50ml nitric acid II 500ml methanol 500ml ethanol 50ml nitric acid III 500ml acetone 500ml methanol Solutions should be in stainless steel beakers. Agitate foil in soln. I until holes appear. Transfer to soln. II, which thins at a slower rate. When suitably thin, transfer to soln. III, agitate, and rinse in methyl alcohol. Dry foil between filter papers	20–23 V, 0–5°C rinse rapidly in methanol and dry between fil- ter papers
Manganese Mn MnBi (Liu, 1972)	Each metal was vapour deposited separately and then the bi-metal foil was annealed to effect a solid-state reaction	
Mu–Cu alloys (Butler and Kelly, 1968)	<i>Chemical:</i> 50 % nitric acid 25 % acetic acid 25 % water <i>Electropolish:</i> 500ml acetic acid 100g chromium hydroxide 15–20ml water	20 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
MnO (Barber and Evans, 1971)	<i>Chemical polish:</i> mixture of dilute hydrochloric and nitric acid	
MnO (Delavignette and Amelinckx, 1970)	<i>Chemical polish:</i> hydrochloric acid Single crystals cleaved on {001} plane, then chemically polished	
Manganese spinels, $Mn_xFe_{3-x}O_4$ (van Landuyt et al., 1972)	Ion bombardment of single crystal slices	
Manganese silicides, Mn-Si (de Ridder and Amelinckx, 1971)	Material crushed and fragments placed on carbon film	
Magnesium aluminate spinel, $MgO.3Al_2O_3$ (Aeschlimann et al., 1970)	Crystal wafers chemically polished in pyrophosphoric acid	
Sulphospinel, $MnCr_2S_4$, etc. (Tressler and Stubican, 1967)	Powdered material evaporated onto crystal substrates and floated off onto grids	
<i>Molybdenum, Mo</i>		
Mo (Kopetskii and Pashkovskii, 1974)	<i>Jet polish:</i> 12% sulphuric acid 88% methyl alcohol	
Mo (Vesely, 1973)	<i>Electrothin:</i> 1 part sulphuric acid 7 parts methanol <i>Electropolish:</i> conc. sulphuric acid	
Mo (Clauer et al., 1970)	<i>Jet:</i> 15% nitric acid 85% water <i>Electropolish:</i> 14% sulphuric acid 86% ethanol Final polishing at 14 V, reduced to 5 V just before perforation	35-40 V 5-14V, room temp.
Mo (Rau et al., 1970)	<i>Jet:</i> 12.5% sulphuric acid 87.5% methanol Final polish by immersion in stirred jet electrolyte	6-8 V, 0°C
Mo (cold-rolled) (Guttman, 1970)	<i>Electropolish:</i> 20% sulphuric acid 80% methanol	
Mo (Irwin and Otto, 1968)	<i>Electrothin:</i> 13% sulphuric acid	39 V, 15.8 A/cm ²

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	87 % methanol	0–5°C stainless steel or platinum cathode
	<i>Electropolish:</i> 14 % sulphuric acid 86 % ethyl alcohol	Room temp., 14 V
Mo (fine particles) (Vahldiek and Pence, 1967)	Using Ti thin films as a getter, fine particles of Mo are observed at high temperatures with a minimum of oxidation	
Mo (Hepfer, 1966)	<i>Jet:</i> 15 % nitric acid 85 % water	110 V, 25°C
	<i>Electropolish:</i> 25ml sulphuric acid 150ml ethanol	14 V, 0.8–1.2 A / cm ² 25°C, stirring necessary
Mo (Mastel and Brimhall, 1965)	<i>Electropolish:</i> 25ml hydrochloric acid 10ml sulphuric acid 75ml methanol	18 V, 0.9 A/cm ² , 10°C
Mo (Higgins and Roberts, 1964)	<i>Electropolish:</i> 93 % sulphuric acid 7 % water Wash in hot distilled water	0.8–1.0 A / cm ² , 50°C
Mo (wire) (Meieran and Thomas, 1963)	<i>Jet:</i> 25 % sulphuric acid 10 % hydrochloric acid 65 % ethanol	Platinum–glass electrode
	<i>Electropolish:</i> 25 % sulphuric acid 75 % ethanol	
Mo, Mo alloys (Wilcox and Gilbert, 1967; Loesch and Brotzen, 1967)	<i>Electropolish:</i> 75 % ethanol 25 % sulphuric acid	– 30°C
Mo ₂ C (Mersol et al., 1966)	<i>Chemical polish:</i> mixture of dilute nitric and sulphuric acids	
Mo containing Ti and Zr carbides (Raffo, 1970)	<i>Electropolish:</i> 14 % sulphuric acid 86 % ethanol	30 V, 5–10°C
MoO ₂ and MoO ₃ (Vahldiek, 1968b)	Small oxide crystals grown by heating Mo powder	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Mo-Re (Mahajan, 1973)	<i>Jet:</i> 15% nitric acid 85% water <i>Electropolish:</i> 25% sulphuric acid 75% methanol	0°C
Mo-Re (Witcomb et al., 1968)	<i>Electropolish:</i> conc. sulphuric acid	15 V, 1 A/cm ²
Mo-Re alloys (Ogawa and Maddin, 1964)	<i>Electropolish:</i> sulphuric acid	Stainless steel cathode
Mo-Re (Votava, 1962)	<i>Electropolish:</i> 12.5% sulphuric acid 87.5% methanol Use old electrolyte; it etches when freshly made	1 A/cm ² , stainless steel cathode
Mo-Ru alloys (Flewitt and Tate, 1972)	Argon-ion bombardment	
Mo-Zr (Mukherjee and Martin, 1963)	<i>Electropolish:</i> 5% sulphuric acid 1.25% hydrofluoric acid in methanol	55 V, 5 A/cm ²
Neon, Ne Ne, solid (Goringe and Valdré, 1964)	Using a liquid helium cooling stage, neon has been introduced into the microscope and deposited on various substrates ($\geq 10\text{K}$)	
Sodium, Na NaF-NaMgF ₃ eutectic (Bright and Lewis, 1971b)	Extracted plates of NaMgF ₃ were electron transparent, as were cleavage slices	
Nickel, Ni Ni (polycrystalline) (Singh and Tangri, 1970)	<i>Jet polish:</i> 48% orthophosphoric acid 32% sulphuric acid 20% water	5 V, 0.2-0.3 A/cm ²
Ni (Leverant and Sullivan, 1968)	<i>Electropolish:</i> 40% orthophosphoric acid 35% sulphuric acid 25% water	6 V, -5°C
Ni (Murr et al., 1968)	<i>Electropolish:</i> 850ml orthophosphoric acid 51ml sulphuric acid 100g chromium trioxide	$\leq 15^\circ\text{C}$

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	Wash in distilled water and ethanol	
Ni (cold-worked) (Michels and Ricketts, 1967)	<i>Electropolish:</i> 26 % nitric acid 74 % methanol	7–9 V, 0.15 A/cm ² 10–15°C
Ni (Richardson et al., 1966)	<i>Chemical</i> (1 min): 30 % nitric acid 10 % sulphuric acid 10 % orthophosphoric acid 50 % acetic acid Quickly rinse in water after chemical thinning <i>Electropolish:</i> 4 parts sulphuric acid 4 parts water 3 parts glycerin	85–95°C 18 V, < 10°C agitate solution
Ni (Nolder and Thomas, 1964)	<i>Electropolish:</i> 60 % sulphuric acid 5g/l <i>p</i> -toluene-sulphonic acid	10°C
Ni (hydrogen-charged) (Wilcox and Smith, 1964)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	15 V, 0.3–0.7 A/cm ²
Ni alloys (Mankins et al., 1974)	<i>Jet:</i> 10 % nitric acid 90 % water <i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid	 Platinum cath- ode
Ni–Al alloys (Nordstrom and Barrett, 1972)	<i>Electrothin:</i> 80 % methanol 20 % sulphuric acid <i>Electropolish:</i> 90 % ethanol 10 % perchloric acid	36 V, 10°C
Ni–Al alloys (Kirkwood, 1970; Ardell and Nicholson, 1966)	<i>Electropolish:</i> 10 % perchloric acid 90 % ethanol On perforation: 1. Specimen inverted until second perforation has occurred 2. Solution vigorously stirred 3. Voltage increased to 23 V	18–20 V, 0°C
Ni–Al alloys (Starke et al., 1965)	<i>Electropolish:</i> 144ml ethanol	–20°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	32ml water 16ml <i>n</i> -butyl alcohol 45g zinc chloride 10g aluminium chloride	
Ni – 12.7at. %Al (Phillips, 1966b and 1967)	<i>Electropolish:</i> 50% orthophosphoric acid 50% water	150 V
NiAl or NiAl + Ni ₃ Al precipitate (Moskovic, 1973)	<i>Jet:</i> 15% nitric acid	90 V
	<i>Electropolish:</i> 5% perchloric acid 95% ethyl alcohol	0°C, 5 V
NiAl (Lautenschlager et al., 1966)	<i>Electropolish:</i> 63% methanol 35% 2-butoxyethanol 2% perchloric acid	
NiAl ordered compound (Ball and Smallman, 1966 and 1968)	<i>Electropolish:</i> 10% perchloric acid 90% acetic acid	
Ni ₃ Al alloys (Corey et al., 1973)	<i>Electropolish:</i> 20% perchloric acid 15% butyl cellusolve 15% water 50% ethanol	4°C
Ni ₃ Al (Thornton et al., 1970)	<i>Electropolish:</i> 10% sulphuric acid 90% methanol	12 V, approx. 3°C
NiAl – Cr eutectic (Walter et al., 1969)	<i>Electropolish:</i> 62ml perchloric acid 700ml ethanol 100ml butyl cellusolve 137ml water	
Ni – Al – W (Mulford and Pope, 1973)	<i>Electropolish:</i> 10% sulphuric acid 90% methanol	10 V, 5°C 1 A/cm ²
Ni containing Al ₂ O ₃ whiskers (Stapley and Beevers, 1969)	<i>Electropolish:</i> 12.5% sulphuric acid 55.5% phosphoric acid 32% water	70°C
Ni – Be – Cr (Shen and Griffiths, 1970)	<i>Electropolish:</i> 450ml acetic acid 40ml perchloric acid 15ml water	Foils difficult to prepare

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Ni–Co (multi-phase alloys) (Graham and Youngblood, 1970)	<i>Jet polish:</i> 600ml methanol 100ml hydrochloric acid	40 V
Ni–Co (Howie and Swann, 1961)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	6–8 V, 0°C
Ni–Co–Cr alloys (Köster et al., 1964)	<i>Electropolish</i> (Jacquets' solution): 85 % acetic acid 10 % perchloric acid 5 % water	
Ni–Cr alloys (Gibbons and Hopkins, 1974)	<i>Electropolish:</i> 20 % perchloric acid 80 % alcohol	5°C
Ni–Cr alloys (Raymond, 1967)	<i>Jet:</i> 10 % nitric acid 90 % methanol <i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid	
Ni–Cr eutectic (Kossowsky et al., 1969)	<i>Jet polish</i> (Ni-rich phase): 23 % perchloric acid 77 % acetic acid Hole is masked and polishing continued with: <i>Jet polish</i> (Cr-rich phase): 42 % phosphoric acid 34 % sulphuric acid 24 % water	25–30 V 0.7 A/cm ² 2.8 V 0.1–0.2 A/cm ²
Ni–Cr–Co alloys (Davies et al., 1973)	<i>Jet:</i> 40 % acetic acid 20 % nitric acid 30 % orthophosphoric acid 10 % water <i>Electropolish:</i> 10 % perchloric acid 90 % ethanol	60 V 8 V
Ni–Cr–Co, Ni–Cr–Fe (Ramaswamy et al., 1972)	<i>Electropolish:</i> 10 % perchloric acid 90 % ethanol	–25°C
Ni–Cr–Fe (Pellier, 1963)	<i>Electropolish:</i> 59 % glycerol 20 % water 11 % sulphuric acid 10 % orthophosphoric acid	15 V
Ni–Cr–ThO ₂ (Thompson, 1974)	<i>Electropolish:</i> 30ml perchloric acid (30 %)	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	175ml <i>n</i> -butyl alcohol 300ml methanol	
Ni–Cr–ThO ₂ alloys (Killpatrick and Young, 1970)	<i>Chemical:</i> 29g ferric chloride 10ml hydrochloric acid 1 litre water	65°C
	<i>Electropolish:</i> 700ml ethanol 100ml 2-butoxyethanol 120ml water 78ml perchloric acid	15 V, –29°C
Ni–22%Fe (Dash and Brown, 1963)	<i>Electrothin:</i> 10% perchloric acid 90% acetic acid	
	<i>Electropolish:</i> 133ml acetic acid 25g chromium trioxide 7ml water	
Ni ₃ Fe (Liu and Arko, 1971; Arko and Liu, 1971)	<i>Chemical:</i> 45% water 30% nitric acid 10% hydrofluoric acid 15% hydrochloric acid	
	<i>or</i> 30% nitric acid 15% hydrochloric acid 45% water	
	<i>Electropolish:</i> 5% perchloric acid 95% acetic acid	75 V
Ni–Fe–Cr–Nb (Kirman and Warrington, 1970)	<i>Electropolish:</i> 1% perchloric acid 99% methanol	–70°C
Ni–Fe–Mo–Zr alloy (Frohlich et al., 1974)	<i>Electropolish:</i> 50% perchloric acid 50% acetic acid	20 V
Ni ₃ Ga (Takeuchi and Kuramoto, 1973)	<i>Electropolish:</i> 860ml orthophosphoric acid 50ml sulphuric acid 100g chromium trioxide	0°C
NiMn (Kraševac et al., 1967)	<i>Electropolish:</i> 10% perchloric acid 90% acetic acid	
Ni ₃ Mn (Marcinkowski and Poliak, 1963)	<i>Electropolish:</i> 25g chromium trioxide	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	133ml glacial acetic acid 7ml water	
NiMo (van Tendeloo and Amelinckx, 1973)	<i>Electropolish:</i> 264ml ethylene glycol 38ml hydrofluoric acid 38ml perchloric acid 18ml water	
Ni–Mo alloys (Lefevre et al., 1968; Chakravarti et al., 1970)	<i>Jet and electropolish:</i> 33 % sulphuric acid 67 % water	
Ni ₂ Mo, Ni ₃ Mo, Ni ₄ Mo (Das and Thomas, 1974)	<i>Electrothin:</i> 396ml ethylene glycol 57ml perchloric acid 57ml hydrofluoric acid 27ml water	10°C, 9–11 V
	<i>Jet polish:</i> 67 % sulphuric acid 33 % water	Total current < 10 mA
Ni ₃ Mo (van Tendeloo et al., 1973)	<i>Jet polish:</i> 264ml ethylene glycol 38ml perchloric acid 38ml hydrofluoric acid 18ml water	
Ni ₄ Mo (Saburi et al., 1974)	<i>Jet:</i> 1 part perchloric acid 6 parts ethylene glycol <i>Electropolish:</i> 25 % nitric acid 75 % methanol	
Ni ₃ Mo (Liu, 1970)	<i>Jet:</i> 10 % perchloric acid 90 % acetic acid <i>Electropolish:</i> 75 % ethylene glycol 10 % perchloric acid 10 % hydrofluoric acid 5 % water	25 V
Ni–Ni ₃ Nb eutectic (Annarumma and Turpin, 1972)	<i>Electropolish:</i> 10 % perchloric acid 90 % ethanol or 150g chromium trioxide 800ml acetic acid 42ml water	
Ni oxide films	Oxide films stripped from substrate using	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
(Perrow et al., 1967 and 1968)	saturated solution of iodine in ethanol. Stripped films washed several times in methanol	
Surface oxide of nickel alloys (Wlodek 1964a and b)	Thin films stripped from oxidised specimen surface by scoring surface into approx. 2mm grids and overetching electrolytically in: 10 % sulphuric acid 90 % ethanol	
Ni–Si (internally oxidised) (Cundy and Grundy, 1966)	<i>Electropolish:</i> 36 % orthophosphoric acid 36 % glycerin 28 % water	20 V platinum cathode
NiSn _x (Wynne et al., 1972)	4000 Å thick films electrodeposited onto copper substrate. Film stripped from substrate using ammoniacal hydrogen peroxide solution	
Ni–Ta alloys (Detert and Ziebs, 1965)	<i>Electropolish:</i> 23 % perchloric acid 77 % acetic acid	0.4 A/cm ² , 15°C
TD nickel (ThO ₂) (Ham and Wayman, 1967; Petrovic and Ebert, 1972)	<i>Chemical cleaning:</i> 50 % acetic acid 30 % nitric acid 10 % phosphoric acid 10 % sulphuric acid <i>Electropolish:</i> 40 % orthophosphoric acid 35 % sulphuric acid 25 % water	85°C 6V, < –5°C
TD nickel (Olsen et al., 1971)	<i>Jet polish:</i> 20 % perchloric acid 80 % ethanol	
Ni–Ti alloys (Ardell, 1969 and 1970)	<i>Electropolish (discs):</i> 30 % nitric acid 70 % methanol <i>Electropolish (discs or sheet):</i> 10 % perchloric acid 90 % ethanol	8–10V, –60 to –30°C 18–20 V, 0°C
Ni–Ti (equi-atomic alloy) (Marcinkowski et al., 1968; Koskimaki et al., 1969)	<i>Electropolish:</i> 6 % perchloric acid 94 % methanol	–76°C
Ni–Ti–Al–Nb (Cozar and Pineau, 1973)	<i>Electropolish:</i> 10 % perchloric acid 90 % ethanol	0°C, 15 V
Ni–Ti–C (Scarlin et al., 1971)	<i>Electropolish:</i> 10 % perchloric acid 90 % ethanol	30 V, –50°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Ni – V (Moreen et al., 1974)	<i>Jet polish:</i> 40 % sulphuric acid 60 % water	14 V, room temp. 60–100 mA
Ni – W (Lasalmonie and Martin, 1974)	<i>Electropolish:</i> 87ml methanol 8ml sulphuric acid 5ml lactic acid 2ml hydrofluoric acid	14 V, 0°C vigorous stirring
Ni – W – Co – Cr (Mar-M200) (Kear and Hornbecker, 1967)	<i>Jet:</i> 10 % sulphuric acid 1 % hydrofluoric acid 1.5 % nitric acid in methanol <i>Electropolish:</i> same solution	Approx. 250 V 13–15 V, 0.16 A/cm ² max. temp. 27°C
Ni – Y ₂ O ₃ alloy (Cairns, 1974)	<i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid	20 V, 200 mA
Ni-base alloys (Leverant and Kear, 1970)	<i>Electropolish:</i> 83 % methanol 7.5 % sulphuric acid 3 % nitric acid 2 % hydrofluoric acid 4.5 % lactic acid	10 V, room temp.
Ni alloys (Larson et al., 1969)	<i>Jet polish:</i> 57 % sulphuric acid 43 % water	10 V
Ni-base alloys (Beardmore et al., 1969)	<i>Electropolish:</i> 20 % perchloric acid 70 % ethanol 10 % butyl cellusolve	Solution con- stantly stirred
Ni-base superalloys (Kotval and Nestor, 1969)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	22 V, 0°C
Hastelloy X-280 (Levy et al., 1967)	<i>Chemical jet polish:</i> 75ml sulphuric acid 115ml water Al evaporated onto thinned specimens as an internal standard for electron diffraction analysis	Room temp.
Niobium, Nb Nb (Schrober and Sorajić, 1973)	<i>Electropolish:</i> 0.05 molar magnesium perchlorate per litre of	50–70 V, – 5°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	methanol	no uptake of hydrogen
Nb (Sikka et al., 1973)	<i>Jet polish:</i> 558ml methanol 30ml sulphuric acid 12ml hydrofluoric acid	110–115 V, –48°C 30–32 A/cm ²
Nb (wires) (Dollins and Wert, 1969)	<i>Jet:</i> 70 % methanol 20 % sulphuric acid 10 % hydrofluoric acid <i>Chemical polish:</i> 1 part lactic acid 1 part nitric acid 1 part hydrofluoric acid	200 V Chemical polish- ing time approx. 15 min
Nb and Nb alloys (Hepfer, 1966; Schlump et al., 1972)	<i>Chemical jet:</i> 60 % nitric acid 40 % hydrofluoric acid <i>Chemical polish:</i> 70 % nitric acid 30 % hydrofluoric acid Washing important: distilled water, purified acetone, the ethanol baths, followed by drying in a stream of hot air	25°C Mix in ice (0°C)
Nb (Pelleg, 1967)	<i>Electropolish:</i> 18 % hydrofluoric acid 34 % sulphuric acid 48 % lactic acid	4.2 V
Nb (Taylor and Christian, 1967)	<i>Chemical:</i> 70 % nitric acid 30 % hydrofluoric acid <i>Jet polish:</i> 90 % sulphuric acid 10 % hydrofluoric acid Use freshly prepared electrolyte. Wash in water and alcohol	10–20 V, p.t.f.e. holder
Nb (Fourdeux and Wronski, 1964; Wronski and Fourdeux, 1964a)	<i>Electropolish:</i> 17.5 % hydrofluoric acid 17.5 % nitric acid 65 % water	4–5 V, 40°C Pt crucible (cath- ode)

or

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	85 % sulphuric acid (s.g. 1.84) 15 % hydrofluoric acid (40 %)	8 V, 59°C Pt cathode
Nb alloys (Gidley and Davies, 1967)	<i>Electropolish:</i> 90 % methanol 10 % perchloric acid	5.5 V, – 30°C
Nb – C alloys (Chang et al., 1974)	<i>Jet:</i> 70 % methanol 20 % sulphuric acid 10 % hydrofluoric acid <i>Electropolish:</i> 50ml lactic acid 21ml nitric acid 19ml hydrofluoric acid	95–100 V room temp.
	Wash foils thoroughly in distilled water, aqua regia, and absolute ethyl alcohol, at each step of process	
Nb ₆ C ₅ (Morgan and Lewis, 1974)	<i>Electropolish to perforation:</i> 5 % sulphuric acid 95 % methanol Final step: ion-beam thinning on both surfaces	
Nb – H alloys (Westlake, 1969)	<i>Electropolish:</i> 90 % sulphuric acid 10 % hydrofluoric acid	30 V, 14°C
Nb–38at. % Hf (Koch and Carpenter, 1972)	<i>Electropolish:</i> 2 % perchloric acid 98 % methanol	– 65°C
Nb – Nb ₂ N (Deschanvres et al., 1974)	<i>Jet:</i> 85 % sulphuric acid 15 % hydrofluoric acid <i>Electropolish:</i> 85 % hydrochloric acid 15 % hydrofluoric acid	20 V, 65°C Room temp.
Nb ₂ O ₅ (Spyridelis et al., 1967b)	Amorphous films produced by anodising metal sheet. These films recrystallised in the microscope	
Mixed oxides of niobium (Allpress, 1969)	Material ground in an agate mortar, dispersed in methyl chloroform and collected on carbon-coated grids	
Niobium ditelluride (van Landuyt et al., 1970)	Repeated cleavage along <i>c</i> -plane of single crystals produced thin foils	
Nb – Ti (Witcomb and Dew-Hughes, 1973)	<i>Chemical thinning and chemical polishing of heavily cold-worked specimens:</i> 50 % nitric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	30 % sulphuric acid 20 % hydrofluoric acid <i>Chemical polishing of annealed specimens:</i> 70 % nitric acid 10 % sulphuric acid 20 % hydrofluoric acid	
Nb-44wt. %Ti (Baker, 1970)	<i>Chemical polish:</i> 1 part hydrofluoric acid 1 part nitric acid 1 part sulphuric acid	Hot
Nb-V alloys (Hobson et al., 1965)	<i>Chemical:</i> nitric and hydrofluoric acids <i>Electropolish:</i> 10 % hydrofluoric acid 90 % sulphuric acid	
Nb-Zr (β -phase) (Flewitt and Palmer, 1973; Flewitt, 1974)	<i>Electropolish:</i> 5 % sulphuric acid 2.5 % hydrofluoric acid 92.5 % methanol	25 V, -73°C
Nb-25 %Zr (Milne, 1972)	<i>Electropolish:</i> 85 % sulphuric acid (s.g. 1.84) 15 % hydrofluoric acid (40 %) Cleaned ultrasonically in methanol	20 V, 20°C Pt wire cathode
Nb-25Zr (wire) (Thompson and Flewitt, 1970)	Argon-ion bombardment. Fine wire specimens.	20° tilt, 4-5 kV, 40 μ A
Nb-40 %Zr (Finlayson and Milne, 1972)	<i>Electropolish:</i> 15 % perchloric acid 85 % methanol Final thinning done by ion bombardment	15 V, -123°C stainless steel cathode
Nb and Nb-Zr (Stickler and Engle, 1963)	<i>Jet:</i> 5 % sulphuric acid 2 % hydrofluoric acid 93 % methanol <i>Electropolish:</i> same as jet solution	300 V, 10 A/cm ² , -60°C 20 V, 0.5 A/cm ² , -60°C
Osmium, Os Os (Melmed and Carroll, 1973)	<i>Electropolish:</i> 10 % hydrochloric acid 90 % water or	20-40 V a.c.

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	1 normal KOH solution	
Oxide films on Fe–Cr alloys (Cox et al., 1974)	Oxide films were stripped from the metal substrate using an anhydrous saturated solution of iodine in methanol	
<i>Palladium, Pd</i> Pd (Tousek, 1970)	<i>Electropolish:</i> 33 % sulphuric acid 33 % orthophosphoric acid 34 % nitric acid	a.c. current 0.2–0.5 A/cm ²
Pd and Pd–Ag (Kushner, 1968)	<i>Electropolish:</i> 50 % methanol 33 % nitric acid 17 % phosphoric acid	
Pd (Singh and Murr, 1972)	Thin films vapour-deposited onto cleaved NaCl (001) substrates. Films were floated off in water and picked up on EM 200 mesh grids	
Pd ₈₀ Si ₂₀ (Duhaj et al., 1973/74)	<i>Electropolish</i> (for splat-cooled foils): 77 % acetic acid 23 % perchloric acid	
<i>Platinum, Pt</i> Pt (Ahlers and Balluffi, 1967; Newman and Hren, 1971)	<i>Electropolish:</i> 60 % saturated solution of calcium chloride in water (s.g. 1.46g/ml) 36 % water 4 % hydrochloric acid	10 V (a.c.) stir solution
Pt (Tousek, 1970)	<i>Electropolish:</i> 33 % sulphuric acid 33 % orthophosphoric acid 34 % nitric acid	a.c. current 0.2–0.5 A/cm ²
Pt (Gath et al., 1969)	<i>Jet polish:</i> saturated solution of calcium chloride in water For annealed specimens add 0.5 % hydrochloric acid. Wash in dilute hydrochloric acid	20–100 V (a.c.), p.t.f.e. holder
<i>Plutonium, Pu</i> Pu–1 %Ga (Brewer and Fraikor, 1967)	<i>Jet polish:</i> 17 % sodium chromate 83 % acetic acid Wash in acetic acid and then methanol	40 V, 25°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
<i>Rhenium, Re</i> Re (Vandervoort and Barmore, 1969)	<i>Electropolish:</i> 60% ethanol 30% perchloric acid 10% butoxyethanol	35 V, -40°C
Re (Carpenter and Paris, 1968)	<i>Jet:</i> 3% sodium hydroxide 97% water <i>Electropolish:</i> 20% perchloric acid 80% ethanol	210 V, room temp. 20 V, -40°C
Re (Brimhall and Mastel, 1965)	<i>Electropolish:</i> 23% perchloric acid 77% acetic acid	6-18 V, 0.3 A/cm ² < 20°C
<i>Ruthenium, Ru</i> Ru single crystal (Snow and Breedis, 1974)	<i>Electropolish:</i> 78g CaCl ₂ ·2H ₂ O 200ml water 6ml hydrochloric acid (conc.)	10 V reduced to 7 V 0°C (200 and 100 mA / mm ² , respectively)
<i>Samarium, Sm</i> SmCo ₅ (Riley, 1974)	<i>Jet:</i> 10% hydrochloric acid 90% water <i>Electropolish to perforation:</i> 15% perchloric acid 85% acetic acid wash in methanol Final step: ion bombardment around perforation	50 V 10 V
<i>Selenium, Se</i> Se (Crystal, 1970)	Amorphous films were vacuum deposited onto nitrocellulose support films	
Se (Griffiths and Sang, 1967)	Polycrystalline and amorphous thin films were vacuum deposited onto (001) faces of alkali halides	
<i>Silicon, Si</i> Si (Tsunekawa and Weissmann, 1975)	<i>Chemical polish:</i> 1 part hydrofluoric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	3 parts nitric acid 2 parts acetic acid	
Si (Szilva et al., 1974)	Use black-wax protective coatings to outline the desired area and <i>Chemical polish:</i> 75% nitric acid 25% hydrofluoric acid	
Si (Ohlidal and Orel, 1974)	<i>Chemical:</i> 9 parts nitric acid (60%) 1 or 2 parts hydrofluoric acid (48%) followed by anodic oxidation in the final stages	
Si (Hill and Rowcliffe, 1974)	<i>Chemical jet:</i> very dilute hydrofluoric acid Final polishing by ion bombardment	300 V
Si (Moss and Flynn, 1973)	Wafers of Si covered with a paraffin solution from which the solvent was evaporated. A small hole was exposed in the paraffin and the Si crystal gently etched in a dilute hydrofluoric acid plus nitric acid solution until a hole just formed	
Si (Merli and Valdré, 1972)	<i>Chemical jet:</i> 82% nitric acid 18% hydrofluoric acid (48%) Jet apparatus described for simultaneous cutting and thinning of disc specimens	
Si (Phillips and Hugo, 1970)	<i>Chemical:</i> 90% nitric acid 10% hydrofluoric acid	55°C
Si films (Linnington, 1970)	Ion bombardment	
Si (Stickler and Booker, 1963)	<i>Chemical jet polish:</i> 46% nitric acid 27% hydrofluoric acid 27% acetic acid	
Si (Booker and Stickler, 1962)	<i>Chemical jet polish:</i> 90% nitric acid (60%) 10% hydrofluoric acid (48%)	
SiC (Stevens, 1971a)	Discs cut ultrasonically. Thinned by argon ion bombardment	
SiC whiskers (Stevens, 1972)	The whiskers were cleaned by soaking for 30 min in hydrofluoric acid to remove most of the protective SiO ₂	
SiC (Jackson and Howard, 1965)	SiC films removed by etching-away silicon substrates with hydrofluoric acid–nitric acid mixtures	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
β -SiC (Comer, 1969)	Single-crystal whiskers placed in 48% hydrofluoric acid solution to remove oxide. Water suspension of whiskers allowed to dry on coated 200 mesh grids	
SiC-6H (van Landuyt and Amelinckx, 1971)	Ion bombardment	
Silicon nitride, α - and β -Si ₃ N ₄ (Evans and Sharp, 1971)	Ion bombardment	
SiO ₂ (McLaren and Phahey, 1965)	Small pieces of mineral were crushed between two glass microscope slides. Slides separated and a carbon film deposited. Film floated off in water, carrying with it a large number of crystal fragments	
Silver, Ag Ag polycrystalline (Slakhorst, 1975)	<i>Electropolish:</i> 67.5g potassium cyanide 15g potassium-sodium tartrate 15g potassium ferrocyanide 19.5ml orthophosphoric acid 2.5ml ammonium hydroxide (in 1 litre water)	
Ag (Cockayne et al., 1971)	<i>Jet:</i> 15% nitric acid 85% water <i>Electropolish:</i> 1% perchloric acid 9% glycerol 90% methanol	40 V 20 V, -60°C
Ag, Ag-Zn alloys (dilute) (Gallagher and Liu, 1969)	<i>Electropolish:</i> 6g potassium cyanide 100ml water	6-8 V, room temp.
Ag-Al (Hawbolt and Brown, 1968)	<i>Electropolish:</i> 10% glycerol 20% perchloric acid 70% ethanol	20-40 V, -20°C
Ag-Al (Okamoto and Thomas, 1967)	<i>Electropolish:</i> 3.0g potassium cyanide 1.5g sodium hydroxide 0.5g silver cyanide 0.3g potassium carbonate 100ml water	3 V, 0.02 A/cm ² , -5°C
Ag-Al alloys (internally oxidised) (Swann et al., 1964)	<i>Electropolish:</i> 10% potassium cyanide aqueous solution	10 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	Current supplied in pulses (2 pulses/s) of approx. 0.2s duration, to prevent formation of an adhering anodic film	
Ag–Cd (β -alloys) (Krishnan and Brown, 1973)	<i>Jet:</i> 50% orthophosphoric acid 50% water <i>Electropolish:</i> 6% potassium cyanide solution	
Ag–In alloys (Gallagher and Washburn, 1966)	<i>Electropolish</i> for dilute alloys: 6g potassium cyanide 100ml water <i>Electropolish</i> for other alloys: 70% ethanol 20% perchloric acid 10% glycerin	2.5 V 10 V, –20°C
Ag–Mg (Brimhall and Huggins, 1965)	<i>Electropolish:</i> 4% potassium cyanide 4% calcium carbonate 4% silver cyanide aqueous solution	
Ag–Sn (Ruff and Ives, 1973)	<i>Electropolish:</i> 12g silver cyanide 12g potassium carbonate 24g potassium cyanide 3000ml water	1.5 V
Ag–Zn (Ayers, 1974)	<i>Jet:</i> dilute nitric acid <i>Electropolish:</i> 10% potassium cyanide solution	12 V a.c.
AgZn (equi-atomic) (Clark et al., 1969)	<i>Electropolish:</i> 9% potassium cyanide aqueous solution	
Sodium, Na (Isaacs and Singer, 1970)	Chemical polishing of Na was effected in mixtures of 5–50% methanol in acetone after removal of mineral oil by petroleum ether	
Strontium, Sr Strontium fluoride (Evans, 1963)	<i>Chemical polish:</i> slice of crystal 0.5mm thick was floated on hydrochloric acid until only small fragments remained <i>Mechanical:</i> crystal cleaved with razor blade along octa-	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	hedral cleavage planes. Areas near edges thin enough for transmission	
<i>Tantalum, Ta</i> Ta (Sikka et al., 1973)	<i>Jet polish:</i> 600ml methanol 30ml sulphuric acid 7.5ml hydrofluoric acid	20 V, 26–28 A/cm ² room temp. wash in ethanol and dry
Ta and Ta alloys (Hepfer, 1966)	<i>Chemical jet:</i> 125ml sulphuric acid 50ml nitric acid 50ml hydrofluoric acid <i>Chemical polish:</i> same solution, mix in ice, stirring necessary	25°C
Ta (Spitzig and Mitchell, 1966)	<i>Electropolish:</i> 90 % sulphuric acid 10 % hydrofluoric acid Wash in water frequently	14 V, 0.1–0.2 A/cm ² platinum cathode
Ta (Barbee and Huggins, 1965)	<i>Electropolish:</i> 10 parts hydrofluoric acid 9 parts sulphuric acid	
Ta–C alloys (Rao and Thomas, 1975)	<i>Chemical polish:</i> 25 % hydrofluoric acid 75 % nitric acid	At, or slightly below, room temp.
Ta–N (Trenzing et al., 1974)	<i>Electropolish:</i> 10 % hydrofluoric acid 90 % sulphuric acid	
Ta ₂ O ₅ (Spyridelis et al., 1967b)	Amorphous films prepared by anodising metal sheet. These films recrystallised in the microscope	
Ta (oxide layer) (van Landuyt and Wayman, 1968)	<i>Jet:</i> 90 % sulphuric acid 10 % hydrofluoric acid Disc specimens rinsed in methanol and water. To study the oxide layer, the specimens were polished from one side only	
Ta–Re (Raffo and Mitchell, 1968)	<i>Electropolish:</i> 80 % sulphuric acid 20 % hydrofluoric acid	p.t.f.e. holder

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Ta – Ta ₂ N (Deschanvres et al., 1974)	<i>Electrothin:</i> 85 % sulphuric acid 15 % hydrofluoric acid <i>Electropolish:</i> same solution at room temp.	20 V, 65°C
Ta – W – Hf alloy (Liu et al., 1973)	<i>Electropolish:</i> 1 part sulphuric acid 5 parts methyl alcohol	Platinum cathode
Tin, Sn Sn (single crystals) (Fourie et al., 1960)	<i>Electrothin:</i> 70 % ethanol 20 % perchloric acid 10 % 2-butoxyethanol <i>Electropolish:</i> 85 % ethanol 5 % perchloric acid 10 % 2-butoxyethanol	12 V, 15°C stir solution
Sn (β -phase) (Yada and Torigoe, 1973)	<i>Electropolish:</i> 20 % perchloric acid 80 % acetic acid	10 V
β -Sn films (Patel et al., 1970)	Thin films were vacuum deposited on sodium chloride substrates. Very low beam intensities necessary to avoid damage to films	
Tin disulphide (Siems et al., 1964)	Single-crystal flakes obtained by sublimation in air. Crystals exhibiting a green interference colour on reflection had suitable thickness	
Sn – Zn eutectic (Jaffrey and Chadwick, 1969)	<i>Jet polish:</i> 70 % methanol 20 % perchloric acid 10 % butyl cellusolve Stainless steel jet nozzles and disc clamps	25 V, 20°C
Titanium, Ti Ti (Pelleg, 1974)	<i>Electropolish:</i> 11.1 % hydrofluoric acid 59.0 % lactic acid 24.6 % sulphuric acid 3.6 % dimethyl sulphoxide 1.7 % glycerine	24–35 V, 97 mA/cm ² 0°C, graphite cathode, stir solution
Ti (Rice et al., 1971; Agrawal et al., 1974)	<i>Chemical:</i> 30 % hydrofluoric acid (48 %)	0°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	70 % nitric acid (70 %)	
	<i>or</i>	
	2 parts hydrofluoric acid (48 %)	0°C
	2 parts hydrogen peroxide	
	3 parts water	
	<i>Electropolish:</i>	
	60 parts methanol	–20°C
	35 parts butyl alcohol	
	6 parts perchloric acid (60 %)	
	<i>or</i>	
	<i>Chemical polish:</i>	
	30 % hydrofluoric acid	
	70 % nitric acid	
	(see paper for complete details)	
Ti and Ti alloys (Blackburn and Williams, 1967; Williams et al., 1971a)	Chemical polishes increase temperature of specimen and produce hydrogen contamination in the α -phase of Ti alloys, resulting in γ -hydride precipitation. Thus chemical methods should be avoided	
	<i>Electropolish:</i>	
	30ml perchloric acid (30 %)	11–20 V, < –25°C
	175ml <i>n</i> -butyl alcohol	0.05–0.10 A/cm ²
	300ml methanol	stainless steel cathode
Ti (polycrystalline) (Hu and Cline, 1968)	Blackburn and Williams electrolyte. Disc specimens rinsed in: 1. 75 % nitric acid 25 % water 2. 30g anhydrous zinc chloride 25ml nitric acid 100ml water (to remove surface film) Then: 3. Washed in methanol and dried	
Ti–Al alloys (Truax and McMahon, 1974)	Chemical method of Rice et al. (1971) for Ti	
Ti–15.5at. %Al (Rosenberg and Nix, 1970)	<i>Electropolish:</i>	
	18ml perchloric acid	30 V, 45°C
	178ml methanol	solution stirred
	104ml butyl alcohol	platinum cathode
	Foil rinsed in methanol and stored in clean Petri dish until needed	
	<i>Cleaning solution:</i>	
	36g zinc dichloride	
	100ml water	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	25 ml nitric acid	
	Immediately before use, foil was dipped in 75 % nitric acid aqueous solution, then dipped in the above cleaning solution, then rinsed in methanol. This procedure suppresses the pick-up of excess hydrogen	
Ti–Al–Sn (Pittinato and Frederick, 1969)	<i>Chemical:</i> 800ml water 169ml hydrofluoric acid 100g chromium trioxide This solution used slightly below room temperature to prevent formation of titanium hydrides. Blackburn and Williams (1967) electrolyte	35 V
Ti–Al–Zr alloy (Imbert, 1974)	Method of Blackburn and Williams (1967)	
TiC (single crystals) (Vahldiek, 1967c; Chermant et al., 1970)	<i>Electropolish:</i> 3 parts nitric acid 1 part acetic acid 1 part hydrofluoric acid 3 parts water Cleaved sections polished	1 V
TiC (Hannink, 1970)	Ultrasonic dishing technique <i>Electropolish:</i> 60 % nitric acid 30 % acetic acid 10 % hydrofluoric acid	4 V platinum cathode
Ti–Cu alloys (Williams et al., 1971a; Lütjering and Weissman, 1970)	Blackburn and Williams (1967) electrolyte	< –25°C
Ti–Cr alloys (Ericksen et al., 1969)	Blackburn and Williams (1967) electrolyte	–40°C
Ti–Mo alloys (Gysler et al., 1974)	<i>Electropolish:</i> 60 % methanol 34 % butanol 6 % perchloric acid	50 V, –20°C
Ti–Mo–Zr–Sn metastable β -titanium (Feeney and Blackburn, 1970)	Blackburn and Williams (1967) electrolyte	
TiNi (Zijlstra et al., 1974)	<i>Electropolish:</i> 6 % perchloric acid 94 % methanol	20 V, –60°C
Ti–Ni alloys (near equi-atomic) (Gupta et al., 1973)	<i>Chemical:</i> 4 parts nitric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	2 parts water 1 part hydrofluoric acid	
	<i>Electropolish:</i> 6 % perchloric acid 94 % methanol	Helical cathode of nichrome wire
TiNi (near equi-atomic) (Sandrock et al., 1971)	<i>Electropolish:</i> 200 parts methanol 33 parts sulphuric acid 13 parts hydrochloric acid (toxic solution—use with care)	
Ti–Nb alloys (Koul and Breedis, 1970)	<i>Electropolish (β-isomorphous alloys):</i> 280ml methanol 15ml sulphuric acid 7.5ml hydrofluoric acid	< –40°C
	<i>Electropolish (all other alloys):</i> 150ml methanol 90ml <i>n</i> -butyl alcohol 15ml perchloric acid	< –40°C
Ti–22at. %Nb (Luhman and Curzon, 1972)	<i>Chemical:</i> 1 part water 1 part sulphuric acid 1 part hydrofluoric acid 1 part nitric acid	< –10°C
Ti–Nb alloys (ω -phase) (Balcerzak and Sass, 1972)	<i>Chemical polish:</i> 4 parts nitric acid 1 part hydrofluoric acid	
Ti–20at. %Nb (Baker and Sutton, 1969)	<i>Chemical polish:</i> 1 part sulphuric acid 1 part nitric acid 1 part hydrofluoric acid	
	or	
	<i>Electropolish:</i> 90 % sulphuric acid 10 % hydrofluoric acid	
TiO ₂ (rutile) (Vahldiek, 1968a)	<i>Chemical polish:</i> orthophosphoric acid	130–160°C
	or	
	sulphuric acid Fracture chips or cleaved sections polished	
TiO ₂ (Hirthe et al., 1967)	Ion thinning. Discharge tube method	
TiO ₂ (Ashbee et al., 1964)	Foils grown in (110) orientation on the cube faces of TiC single crystals	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
TiO ₂ (non-stoichiometric) (van Landuyt and Amelinckx, 1970)	Titanium foils were oxidised in air and the remaining metal dissolved in a 10% bromine–90% ethyl acetate solution. TiO ₂ films were recrystallised in the microscope	
Ti–Ta (Bywater and Christian, 1972)	<i>Jet:</i> Blackburn and Williams (1967) solution; Ti cathode <i>Electropolish:</i> Blackburn and Williams (1967) solution	45–50 V –20°C 0.1 A/cm ² , < –25°C
Ti–9wt. %Ta (Yamane and Ueda, 1966)	<i>Chemical polish:</i> 48% hydrofluoric acid 3% nitric acid 49% water	
Ti–V, β -phase alloys (Ling et al., 1974)	<i>Chemical:</i> 2 parts hydrofluoric acid 1 part nitric acid <i>Electropolish:</i> 150ml methanol 90ml <i>n</i> -butanol 15ml perchloric acid	15 V cooled in dry ice and acetone
Ti–12.6%V alloy (Oka et al., 1972)	<i>Chemical:</i> 1 part hydrofluoric acid 2 parts nitric acid <i>Electropolish:</i> 5% perchloric acid 95% acetic anhydride	–30°C
Tungsten, W W and W alloys (Hepfer, 1966)	<i>Jet:</i> 10g sodium hydroxide 100ml water <i>Electropolish:</i> same solution	20 V, 3–6 A/dm ² 25°C 5 V, 3–6 A/dm ²
W (Wronski and Fourdeux, 1964; Warlimont-Meier et al., 1967)	Foils first 'flash annealed' for 2 s near the melting point. They were then ductile enough to handle <i>Electrothin:</i> 2% sodium hydroxide 98% water <i>Electropolish:</i> 0.5% sodium hydroxide 99.5% water	10 V 10 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
W (single crystals) (Lacefield et al., 1966)	<i>Chemical:</i> 4 parts nitric acid 4 parts hydrofluoric acid (48 %) 3 parts acetic acid <i>Electropolish:</i> 13wt % sodium orthophosphate aqueous solution	26 V
W (wire) (Koch and Walter, 1968)	<i>Electropolish:</i> 10 % sodium hydroxide 90 % water Wires encapsulated in epoxy resin and mechanically ground flat. Exposed wires were electropolished	
W (wire) (Koo, 1967)	<i>Electropolish:</i> 2 % potassium hydroxide 98 % water Wire rolled into ribbon before electropolishing as for sheet	
WO ₃ (Tilley, 1970)	Crystals grown by heating powder (WO ₃) in air. Crystals crushed and fragments observed in transmission	
WO ₃ (Spyridelis et al., 1967)	Crystals prepared from the vapour phase in thin plates	
W-5 % Re (Vandervoort, 1970)	<i>Electropolish:</i> 2 % sodium hydroxide 98 % water	15 V
W, W-Re (Stephens, 1968 and 1970)	<i>Jet:</i> 2 % sodium hydroxide 98 % water <i>Electropolish:</i> Same solution	350 V 12 V
W-Ta (Stephens, 1968 and 1970)	<i>Jet:</i> as above, followed by <i>Electropolish:</i> 2 % sodium hydroxide 20 % hydrogen peroxide (30 %) 78 % water	
W-Si alloys (Morgan et al., 1966)	<i>Jet:</i> 10 % sodium hydroxide 90 % water	30-40 V (d.c.) 20 mA room temp.

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	<i>Electropolish:</i> same solution	50 V (d.c.), 100 mA room temp.
W-ThO ₂ (King, 1969)	<i>Jet:</i> 5 % potassium hydroxide 95 % water	
	<i>Electropolish:</i> same solution	0.3 A/cm ²
W-ThO ₂ (Dunham and Daga, 1973)	<i>Electropolish:</i> sodium hydroxide water glycerine	
Uranium, U α -U (Hudson, 1964)	<i>Electropolish:</i> 133ml acetic acid 25g chromium trioxide 7ml water	35-40 V, 10°C 0.4 A/cm ²
	Cleaning solution: 75 % sulphuric acid 18 % glycerol 7 % water Clean for 20 s using a nickel cathode	6-10 V, room temp. 0.15 A/cm ²
U (Briers et al., 1964)	<i>Electropolish:</i> 54 % water 18 % sulphuric acid 18 % orthophosphoric acid 10 % methanol	15 V platinum cathode p.t.f.e. holder
UC (Bainbridge and Thorne, 1970)	<i>Jet polish:</i> 90-95 % orthophosphoric acid 10-5 % methanol	28-30 V
UC and UC ₂ (Eyre and Bartlett, 1967)	<i>Jet:</i> orthophosphoric acid in methanol Start at 220 V, reduce to 45 V at perforation. Spray with methanol at end to prevent staining. Foils will not keep	
U-Nb-Zr (Giraud-Heraud and Guillaumin, 1973)	<i>Jet polish:</i> 1 part perchloric acid 10 parts methanol 6 parts butyl cellosolve	35-45 V, -20°C
Uranium nitride (Sole and van der Walt, 1968)	<i>Jet and jet polish:</i> Orthophosphoric acid in methanol Cleaved slices thinned	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
$\text{UO}_2 + \text{X}$ (Ashbee, 1966)	<i>Jet polish:</i> nitric acid	Hot
UO_2 (Whapman and Sheldon, 1965)	<i>Electropolish:</i> 78g chromium trioxide 67ml sulphuric acid 310ml orthophosphoric acid 120ml water	15 V, 0.1 A/cm ²
US (Sole et al., 1967)	<i>Jet polish:</i> 80 % orthophosphoric acid 20 % methanol Must have an automatic washing system since electrolyte chemically attacks the specimen	
<i>Vanadium, V</i> V (Bressers and Helbach, 1969)	<i>Jet polish:</i> 20 % sulphuric acid 80 % methanol and a few drops of water Wash in electrolyte solution	60 V
V (Godel and Steeb, 1968)	<i>Electropolish:</i> 5 % oxalic acid 95 % water <i>or</i> 5 % perchloric acid 95 % acetic hydroxide Horizontal specimen and nickel cathode. Wash frequently	10 V, 30°C 24 V, -30°C
V (D'Aragona et al., 1968)	<i>Electropolish:</i> 14 % sulphuric acid 86 % methanol Leave specimen in electrolyte for 30 s after switching off voltage to dissolve oxide film. Initial jet thinning in same solution	10 V
V and V alloys (Bölsing et al., 1969; Kramer, 1970)	<i>Electropolish:</i> 100g/l sodium hydroxide in water Do not prepare using wet grinding or pick-up of hydrogen will occur	5 V
V-C (Change et al., 1974)	<i>Electropolish:</i> 80 % methanol 20 % sulphuric acid	
$\text{VC}_{0.76}$ (Thornton and Govila, 1973)	<i>Electropolish:</i> 20 % sulphuric acid 80 % methanol	7 V

MATERIAL AND REFERENCE	METHOD	CONDITIONS
VC-V ₂ C (Billingham and Lewis, 1971)	<i>Electropolish:</i> 5 % sulphuric acid 95 % methanol	20 V
V ₆ C ₅ (Hiraga, 1973)	<i>Jet polish:</i> 80 % methanol 20 % sulphuric acid	
V ₆ C ₅ , V-V carbide (Venables and Lye, 1969; Diercks and Wert, 1972)	<i>Jet:</i> 20 % sulphuric acid 80 % methanol <i>Electropolish:</i> same solution Ultrasonic dishing technique	7 V
V ₆ C ₅ (Hannink et al., 1971)	<i>Electropolish:</i> 10 % sulphuric acid 90 % methanol	12 V (d.c.), 0°C
V-Co-Ni (Liu, 1973)	<i>Electropolish:</i> 25 % sulphuric acid 75 % methyl alcohol	1 A/cm ² , 0-10°C
V ₃ Ga (Nembach and Tachikawa, 1969)	<i>Electropolish:</i> 8ml sulphuric acid 4ml hydrofluoric acid 100ml ethanol	55 V, -50°C
V charged with H (Cambini et al., 1974)	<i>Electropolish:</i> 20 % sulphuric acid 80 % methanol	5°C
V charged with H during polishing (Takano and Suzuki, 1974)	<i>Chemical:</i> 1 part nitric acid 1 part sulphuric acid 1 part water <i>Electropolish:</i> 20 % sulphuric acid 80 % methanol	7-10°C
V charged with H during polishing (Wanagel et al., 1974)	<i>Chemical polish:</i> 2 parts hydrofluoric acid 1 part nitric acid	< 10°C
Vanadium-hydrogen alloys (Westlake, 1967)	Concentration of hydrogen severely increased or decreased by the six different thinning techniques attempted	
V-N alloys (Potter and Altstetter, 1971)	<i>Electropolish:</i> 20 % sulphuric acid 80 % methanol	
V-O alloys (Gunwaldsen and Potter, 1974)	<i>Electropolish:</i> 20 % sulphuric acid 80 % methanol	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
VO, non-stoichiometric (Bell and Lewis, 1971)	<i>Electropolish:</i> 5 % sulphuric acid 95 % methanol	20 V
(W _{0.35} V _{0.65})O ₅ (van Landuyt et al., 1970)	Needle-shaped crystals were crushed and fragments deposited on EM grid	
β , γ -vanadium suboxides, VO _x (Cambini, 1970; Cambini et al., 1971)	<i>Electropolish:</i> 20 % sulphuric acid 80 % methanol Oxidation of vanadium sheet to give oxide sheet	10 V, 0°C
V ₃ Si (Goringe and Valdrè, 1966)	<i>Initial electropolish:</i> 10 % hydrofluoric acid 40 % orthophosphoric acid 50 % methanol <i>Final chemical polish:</i> 15ml hydrofluoric acid 100ml nitric acid Discs spark-indented in centre	6–16 V, room temp. graphite cathode Room temp.
<i>Yttrium, Y</i> Yttrium aluminium garnet (3Y ₂ O ₃ ·5Al ₂ O ₃) (Hardiman et al., 1973)	Ion bombardment of single-crystal slices	
<i>Zinc, Zn</i> Zn (Spyridelis, 1971)	<i>Electropolish:</i> 50 % orthophosphoric acid 50 % ethyl alcohol	3 V, 0.01–0.03 A/cm ² room temp.
Zn (Tomsett and Bevis, 1969)	<i>Electropolish:</i> 12.5 % nitric acid 18.5 % water	10 V
Zn (Kratochvil, 1966)	<i>Chemical polish:</i> 160g chromium trioxide 20g sodium sulphate 500ml water <i>or</i> 10 % nitric acid 90 % water	
Zn (99.99 %) (Harris and Masters, 1966)	<i>Chemical polish:</i> dilute nitric acid	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Zn–Al (low alloy) (Naziri and Pearce, 1974)	<i>Chemical:</i> aqueous 50–70 % nitric acid solution	To perforation
	<i>Electropolish</i> of perforated edges: 67.5 % ethanol 32.5 % orthophosphoric acid	8–10 V
Zn–20wt. %Al (Naziri et al., 1975)	<i>Chemical:</i> aqueous 50–70 % hydrochloric acid solution	To perforation
	<i>Electropolish:</i> 15 % perchloric acid 85 % methanol	–70°C wash in a dry ice and acetone bath, and etha- nol
Zn–Al eutectoid (Naziri and Pearce, 1973)	<i>Chemical:</i> 50 % hydrochloric acid 50 % water	
	<i>Electropolish:</i> 20 % perchloric acid 80 % methanol	20 V, –70°C
Zn–Al (Melton and Edington, 1973)	<i>Electropolish:</i> 15 % perchloric acid 85 % methanol	20 V, –60°C
Zn–Al (Livingston et al., 1970)	<i>Electropolish:</i> 90 % methanol 10 % perchloric acid	
Zn–Al eutectoid alloys (Lee and Underwood, 1970)	<i>Jet polish:</i> 20 % perchloric acid 80 % ethanol	–30°C
Zn–Al alloys (Nuttall and Nicholson, 1968)	<i>Electropolish:</i> 15 % perchloric acid 85 % methanol	0.08 A/cm ² , –50°C
Zn–1 %Cu (Schultz and Shore, 1968)	<i>Electropolish:</i> chromium trioxide sodium sulphate orthophosphoric acid Several polishing solutions were tried, based on these components	
ZnS (Worthington, 1973)	<i>Jet:</i> 1g chromium trioxide 100ml hydrochloric acid <i>Chemical polish:</i> 80g chromium trioxide 100ml water	85°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Zn–Te (Mufti and Holt, 1972)	ZnTe was evaporated onto Ge discs	
Zirconium, Zr (Kelly and Blake, 1973)	<i>Electropolish:</i> 2 % perchloric acid 98 % methanol	– 70°C
Zr single crystal (Akhtar, 1973)	<i>Electropolish:</i> 5 % perchloric acid 95 % methanol	20 V, – 50°C
Zr alloys (Carpenter and Walters, 1973)	<i>Electropolish:</i> 5 % perchloric acid 95 % ethanol Spurious hydride precipitation avoided by rapid impingement of solution on specimen during jet polishing	70 V, – 50°C
Zr and Zircaloy 2 (Lee, 1970)	<i>Electropolish:</i> 950ml acetic acid 5ml perchloric acid	
Zr alloys (ω -transformation) (Chaturvedi and Tangri, 1969)	<i>Electropolish:</i> 10 % perchloric acid 90 % methanol	5–10 V, – 50°C
Zr (Gulden and Bernstein, 1966)	<i>Electropolish:</i> 20 % perchloric acid 80 % ethanol	< 10°C bath vigorously stirred
Zr (Vahldiek, 1967a)	<i>Chemical and/or electropolish:</i> 4 parts nitric acid 1 part hydrofluoric acid 4 parts water Films oxidised in the microscope and the oxides studied	
Zircaloy 4 (Aqua and Owens, 1967)	<i>Chemical:</i> 5 parts nitric acid 5 parts water 1 part hydrofluoric acid Rinse in distilled water <i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid Electropolish for < 10 s	20 V, room temp. vigorous stirring
ZrB ₂ (Leombruno et al., 1968)	<i>Electropolish:</i> 80 % methanol 20 % perchloric acid	– 20°C

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Zr–Cr–Fe (Slattery, 1968)	<i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid	20 V (open circuit) 12°C
Zr–Zr hydride (Bailey, 1963)	<i>Electropolish:</i> 10 % perchloric acid 90 % acetic acid Foil washed in water	20 V, cool vigorous stirring
Oxide film on Zr (Douglass and van Landuyt, 1965)	Metal substrate dissolved in 10 % bromine 90 % ethanol Oxide films washed in ethanol and rinsed in distilled water	75°C
ZrO ₂ (Vahldiek, 1967d)	<i>Chemical polish:</i> hydrofluoric acid	Hot
ZrO ₂ (Bansal and Heuer, 1972)	Ion bombardment	
Zr–Nb alloys (ω -phase) (Perkins et al., 1970)	<i>Electropolish:</i> 80 % water 19 % nitric acid 1 % hydrofluoric acid	0–2 V
Zr–Nb alloys (Dawson and Sass, 1970)	<i>Chemical polish:</i> 45ml water 45ml nitric acid and between 4 and 10ml hydrofluoric acid, depending on the niobium content	
Zr–Nb–Cu (Tangri and Chaturvedi, 1969)	<i>Electropolish:</i> 10 % perchloric acid 90 % methanol Wash in ethanol at –40 to –30°C, and dry between filter papers	5–10 V, –50°C
Zr–Ti alloys (Banerjee and Krishnan, 1973)	<i>Chemical:</i> hydrofluoric acid nitric acid water <i>Electropolish:</i> <i>n</i> -butanol perchloric acid methanol	–50°C

9.2 Glasses

MATERIAL AND REFERENCE	METHOD
<i>Direct Observation</i>	
Glass-ceramics (Hing and McMillan, 1973)	Materials of low crystallinity were chemically thinned in 5% hydrofluoric acid, 2% hydrochloric acid and 93% water, with agitation. More highly crystalline specimens were mechanically thinned followed by ion-beam thinning
Glasses, ceramics (Bach, 1970; Barber, 1970)	Ion bombardment
Glass-ceramics (Williams et al., 1970)	Careful mechanical grinding method to produce a thin film. Thickness measured by interference colours. Full details of chemical separation of vitreous and crystalline phases
As _{0.05} Sb _{0.10} Se _{0.85} (Myers and Berkes, 1972)	Ultramicrotomy of bulk material
B ₂ O ₃ -PbO-Al ₂ O ₃ (Zarzycki and Naudin, 1969)	Thin films obtained by blowing glass bubbles from the melt
Borosilicate glass (Li and Uhlmann, 1970)	Thin chips from a fracture surface were exposed to 1% hydrofluoric acid aqueous solution for 2 min
Chalcogenide glasses (Pinto 1971; Chaudhari and Herd, 1972; Shappirio et al., 1970; Bagley and Northover, 1970)	Thin films deposited onto rock salt or microscope slide substrates and floated off in water
CdO-B ₂ O ₃ -SiO ₂ PbO-Al ₂ O ₃ -SiO ₂ CdO-B ₂ O ₃ -GeO ₂ (Caslavská et al., 1968)	Direct: thin edges of ground fragments Indirect: Specimens etched in HF or nitric acid fumes before replication
Ge ₁₇ Te ₈₃ -based alloys (Moss and de Neufville, 1972)	Amorphous films sputtered onto carbon-coated nickel grids
Li ₂ O-SiO ₂ -P ₂ O ₅ glasses (James and Keown, 1974)	Slices chemically thinned in 10% hydrofluoric acid, 4% hydrochloric acid and 86% water. During thinning the specimens were rotated at 100 rev/min in the solution to avoid redeposition effects
Li ₂ O-Al ₂ O ₃ -SiO ₂ -Pt (Kumar et al., 1973)	Thin sections of glass further thinned by ion bombardment and then carbon coated prior to observation by T.E.M.
Li ₂ O-SiO ₂ -P ₂ O ₅ (James and McMillan, 1971)	Disc specimens mechanically cut. Specimens coated with Lacomit except over centre portion and chemically indented in 5% HF, 2% HCl, 93% water. When centre is sufficiently indented, Lacomit removed, and only rim coated. Polishing continued until centre sufficiently thin. Wash in distilled water, then methanol
30mol. %LiO ₂ -70mol. %SiO ₂ (Kinser and Hench, 1970)	Discs dimpled by masking edge and immersing in 36% HF, 14% HCl, 50% acetic acid. Finally, mask removed and specimen dipped in 5% HF aqueous solution for short periods until visible hole develops

MATERIAL AND REFERENCE	METHOD
LiO ₂ -Al ₂ O ₃ -SiO ₂ glasses (Barry et al., 1969)	Direct: ultramicrotomy Indirect: Specimens etched with 0.5% HF aqueous solution for 5 s and studied by replication
Lithium-zinc silicate (Stewart et al., 1967)	Blown films were chemically thinned using 5% HF, 2% HCl and 93% water
MoS ₂ , NbSe ₂ (Carter and Williams, 1972)	Layer crystals allowed to absorb metal and organic molecules. Changes in structure observed using cold stage on microscope
0.3PbSe-0.7Ge _{1.5} As _{0.5} Se ₃ (Moynihan et al., 1971)	Direct transmission through edge of chip of glass
Te ₄₇ As ₂₉ Si ₁₄ Ge ₁₀ (Thomas et al., 1972)	Films were sputtered onto glass substrates coated with boric oxide, then floated off the substrate in water or dilute (2%) hydrofluoric acid. Films picked up on Ni or Pt grids
Te ₈₁ Ge ₁₅ As ₄ and others (Chaudhari et al., 1972; Bunton et al., 1971)	Thin films were deposited onto rock salt substrates and removed by dissolving the substrate in water
V ₂ O ₅ -P ₂ O ₅ system (Anderson and Luehrs, 1968)	Blown thin films
<i>Replica Methods</i> Borosilicate glass (Bernheim and Chaklader, 1971)	Direct carbon replicas of freshly fractured surfaces. Chromium, gold or platinum used to shadow surface. Etching agents: 1. Pyrex glass: mixture of 2N HCl, 2N H ₂ SO ₄ , and 2% HF for 2h. 2. Corning glass: distilled water for 10 s.
Spinel mineral group AB ₂ O ₄ (Beall and Duke, 1969)	These crystalline materials can be precipitated in a glass. Replica methods used to study nucleation and growth
Li ₂ O-Al ₂ O ₃ -SiO ₂ (Nakagawa and Izumitani, 1972)	Platinum pre-shadowed carbon replicas
Lithium-zinc silicate (McMillan et al., 1966)	Mechanical polish to 1 μm diamond, etched for 10 s in 2% HF aqueous solution, and phase morphology determined by replicas
PbO-B ₂ O ₃ system (Shaw and Uhlmann, 1969)	Simultaneous platinum carbon shadowed replicas taken from fracture surfaces. Samples stored under kerosene
SiO ₂ -B ₂ O ₃ -Na ₂ O (Srinivasan et al., 1971)	Freshly fractured surface etched with 1% HF aqueous solution before replication. Replicas stripped in 3% HF aqueous solution
Chalcogenide glasses (Bagley and Bair, 1970)	Carbon-platinum shadowed, direct carbon replicas prepared from fresh fracture surfaces
As-Te-Ge-Si system (Bunton, 1971)	Fresh fracture surfaces examined by reflection electron diffraction and replicas before and after etching with 6 parts HF, 7 parts nitric acid and 20 parts acetic acid
GeTeI, GeTeSi systems (Feltz et al., 1972)	Fresh fracture surface treated with oxidising etch. SiO vapour-deposited onto surface and shadowed with Ir/Pt

MATERIAL AND REFERENCE	METHOD
As–Te–Ge–Si system (Phillips et al., 1970a and b)	Bulk slices were etched in 5% HF–5% HNO ₃ –90%CH ₃ COOH solution. Cellulose acetate replicas were prepared and shadowed with Pt/C
As ₂ Te ₃ –As ₂ Se ₃ glasses (Kinser et al., 1972)	Carbon replicas (Pt/Rh shadowed) prepared from etched and un-etched fracture surfaces. Etchant: dilute aqueous KOH solution
As ₂ S _x glasses (Maruno and Noda, 1972)	Carbon replicas shadowed with chromium were prepared from polished or fractured surfaces

9.3 Polymers and Other Organic Materials

MATERIAL AND REFERENCE	METHOD
<i>Direct Observation</i>	
Amylose V complexes (Yamashita and Monobe, 1971)	Drops of crystal suspension were placed on carbon-coated grids and the solvents were evaporated. The specimen was shadowed with platinum–palladium before examination
ABA block copolymers (Leary and Williams, 1973 and 1974)	Copolymer cubes stained with bromine, embedded in epoxy and sectioned by ultramicrotome
Catalyst TiCl ₃ –(C ₂ H ₅) ₂ AlCl (Buls and Higgins, 1970)	Specimen particles are extremely sensitive to air and moisture contamination. Catalyst was dusted on carbon support film and inserted into holder under dry nitrogen atmosphere
Cellulose (St. John Manley, 1971)	Aqueous solution of cellulose sample was placed on E.M. grid and allowed to dry. Shadowed with platinum or platinum–carbon
Cellulose acetate and polyacrylonitrile (Naimark et al., 1970)	Ultramicrotomy. Sections could be etched with methylene chloride–alcohol mixture which dissolves cellulose acetate
Cellulose triacetate (Chanzy and Roche, 1974)	Drops of a crystal suspension in methanol were evaporated on carbon films on a mica base. After drying, the carbon films were floated off on water and mounted on copper microscope grids
Cellulose triacetate (C.T.A.) (Zaspink et al., 1969a)	A solution of C.T.A. and acetic acid was freeze-dried. When acetic acid was completely removed, sections were cut by ultramicrotome of C.T.A. skeleton network. Sections could be etched in mixtures of methyl chloride and alcohol
Cellulose triacetate fibres (Zaspink et al., 1969b)	Thin sections cut by ultramicrotome. Chemical etch was 37.5% ethylene dichloride, 62.5% alcohol
Elastomers (Hess and Marsh, 1965)	Replication of strained sections using gelatin or polyvinyl alcohol, metallic shadowing, and carbon film
Glassy polymers (Kambour and Holik, 1969)	Discussion of use of impregnants prior to ultramicrotomy. Liquid sulphur used to fill crazes in poly (2, 6-dimethyl-1, 4-phenylene oxide)
Nylon 66 (Rusnock and Hansen, 1965)	Nylon embedded in a mixture of epoxy resin and phenolic resin. Thin sections cut by ultramicrotome and stained in a 5% aqueous solution of phosphotungstic acid at 95°C
Organosilican polymers (Linsky, 1971)	Embedding medium was Araldite 6005 resin. Thin sections cut by ultramicrotome using diamond knife

MATERIAL AND REFERENCE	METHOD
Polyamide (Bezruk et al., 1968)	15% polyamide solution in formic acid was evaporated to obtain partially crystalline films. Films were etched with active oxygen using gas discharge method
Polyarylates (Akutin et al., 1970)	Drops of 0.1% solution of the polyarylate in tetrachloroethane were deposited on a mica substrate. After solvent evaporation, the film was floated off the substrate in water
Poly (γ -benzyl L-glutamate) (Rybnikar and Geil, 1972)	P.B.L.G. was grown on (100) cleavage surfaces of NaCl or KCl by submersing substrates in P.B.L.G. solution for a predetermined crystallisation time. After drying the films were shadowed with Pt-C. The alkali halide substrate was dissolved in water and the shadowed film picked up on E.M. grids
Polychloroprene (Andrews and Reeve, 1971)	2% solution of Neoprene W in carbon tetrachloride was cast on the surface of water. Film collected on grids
Polyesters (Kanamoto, 1971)	Crystals in liquid suspension were deposited on E.M. grids. After solvent evaporation, specimen was shadowed with germanium. Layer of gold was used to calibrate diffraction spots
Unsaturated polyesters (Sukhareva et al., 1969)	Drops of resin or lacquer in acetone were deposited in a clean depression. Bubbles were introduced into mixture by means of a pipette. Specimen grid with collodion support film was brought into contact with bubble, forming thin layer of solution on supporting film
Polyethylene single crystals (deformed) (Petermann and Gleiter, 1973b)	Single crystals deposited on cracked carbon films. Crystals bridging cracks can deform substrate-free
Polyethylene films (Petermann and Gleiter, 1973a)	Polymer dissolved in xylene and cooled to room temperature. A drop of polymer solution placed on surface of hot orthophosphoric acid (220°C). Acid allowed to cool, solidifying polymer film
Polyethylene single crystals (Harrison, 1973)	After careful preparation of single crystals, crystals washed and transferred to T.E.M. grids
Polyethylene crystals (Martin, 1969)	Crystals grown on Mylar substrate. Thin sections cut with ultramicrotome. Cutting temperature -120°C, glass knife -30°C. Knife edge wet with ethylene glycol. Specimens stained with iodine vapour
Polyethylene crystals (Satou et al., 1972)	Single crystals grown on collodion film during immersion in xylene solution
Polyethylene film (Vadimsky et al., 1969)	Film attached to silicone rubber by concentrated maple syrup. After deformation, polyethylene film was carbon-coated and floated off substrate. Suitable areas punched out and metal shadowed
Polyethylene fibres in polystyrene (Mencik et al., 1972)	Polystyrene phase dissolved in toluene. Extracted polyethylene ribbons washed in isopropanol and deposited on E.M. grid. Specimen shadowed with platinum and coated with carbon to prevent charging in the electron beam
Polyethylene (Keith et al., 1966)	Polyethylene films were crystallised on a mica substrate. Films were then shadowed and a layer of carbon deposited on them. Carbon film with the adhering polymer was stripped from the mica by flotation on water and caught on 200 mesh copper screen

MATERIAL AND REFERENCE	METHOD
Polyethylene (Reneker, 1965)	Method for observing localised deformations in lamellar crystals using chromium shadowing and carbon film. Deformed crystals and carbon film stripped from Mylar substrate with polyacrylic acid and mounted on E.M. grids
Nascent polyethylene/catalyst (Chanzy and Marchessault, 1969)	Polyethylene films formed over catalyst on glass substrate. Film stripped from substrate and washed in methanol to dissolve exposed catalyst. Film shadowed with Ge and viewed in transmission
Polyethylene terephthalate (Yamashita, 1965)	Single crystals prepared by evaporating the solvent slowly from dilute solution at crystallisation temperature on carbon-coated grids. Specimens shadowed with germanium
Poly-4-methylpentene (Morrow et al., 1967)	Crystals were deposited on E.M. grids by solvent evaporation. Specimens shadowed with platinum
Polypropylene (Hock, 1967)	Staining: Chips of polymer were held for 3 days at room temp. in 5% aqueous solution of phosphotungstic acid containing a trace of wetting agent. Polymer was then dried and embedded in epoxy resin. Sections cut by ultramicrotome
Polypropylene (Sakaoku and Peterlin, 1971; Armond and Atkinson, 1969)	Thin films produced by evaporation of dilute solution of polymer floating on water. Crystalline morphology revealed by etching in aqua regia at 0°C for 5h or in chromic acid at room temp. for 20 min. Films studied by replication
Polypropylene (Buls and Higgins, 1970)	Polymer particles embedded in a polyester resin and sliced with ultramicrotome at liquid nitrogen temperature
Polyimides (Korshak, 1970)	Solution of polymer in dimethylformamide was sprayed onto a carbon substrate and freeze-dried. Specimen shadowed with platinum
Polytetrafluoroethylene (Rahl et al., 1972)	A drop of particle suspension was deposited on a Parlodian membrane on a microscope grid. Shadowed by a 20% palladium-80% platinum alloy
Poly- <i>trans</i> -1,4-butadiene (Stellman and Woodward, 1971)	Crystals deposited from a solution onto grids and shadowed
Polyurethanes (Blokland and Prins, 1969)	Freshly cleaved elastomer surfaces were investigated by replication. Structure revealed by oxygen-gas-discharge etching
Polyvinylidene chloride (Wessling et al., 1973)	Samples dispersed in epoxy resin and sectioned. Staining not necessary
Polyvinylidene chloride (Bailey and Everett, 1969)	Powdered polymer samples suspended in ethanol under ultrasonic vibration. Suspension evaporated on coated E.M. grids
Polyvinylidene fluoride (Gal'perin et al., 1970)	2% solution of polymer in cyclohexanone evaporated on the surface of water. Resultant film shadowed with a gold-palladium alloy.
Petroleum products (Bailey, 1966)	Grind aggregates to a powder and disperse either dry or in suspension. Useful effluents are benzene, <i>n</i> -butyl alcohol and water, using ultrasonic treatment to achieve suspension
Polyphenyl methacrylate and complexes of tetracyanoethylene (Boudevska et al., 1971)	Samples prepared by drop-wise application of a chloroform solution of the polymer or the polymer complex on fresh slices of mica. After the solvent had evaporated, the samples were shadowed with

MATERIAL AND REFERENCE	METHOD
	platinum-carbon and the specimens removed from the substrate by floating off in water
Polystyrene, polybutadiene and acrylonitrile (van Wijngaarden, 1966)	Materials soaked for 5 days in 1 % OsO ₄ in water, then sliced with ultramicrotome
Rubber (natural) (Andrews, 1964)	Solutions of 2 % natural rubber in benzene were evaporated from the surface of water. The crystalline structure of the resultant films was fixed by exposing the films to osmium tetroxide vapour. Metallic osmium is deposited in the amorphous regions whose rubbery nature is simultaneously destroyed, but not in the crystalline regions
SBS copolymer (Dlugosz et al., 1973)	Sections cut at liquid air temperature by ultramicrotome and stained with osmium tetroxide vapour for 1 h
Styrene-butadiene-styrene (Myamoto et al., 1970)	Dilute solution of polymer was evaporated from the surface of distilled water. The resultant film was stained by immersion in 1 % OsO ₄ for 2 days
Styrene-isoprene-styrene (Uchida et al., 1972)	Thin films stained by immersion in 1 % OsO ₄ aqueous solution. The polyisoprene phase is selectively stained
Terephthalamide-nylon single crystals (Livingston and Gregory, 1971)	Crystals isolated from dilute solutions of hexafluoro-2, 2-propandiol
Thermoplastics (A.B.S.) (van Wijngaarden, 1967)	Materials fixed in 1 % OsO ₄ in water, then sliced in the ultramicrotome
Vicose (Banduryan, 1970)	Dilute polymer solution evaporated from surface of an immiscible liquid
Wool fibres (Ingram et al., 1968)	Wool samples embedded in resin and sliced by ultramicrotome. Specimens could be stained in a 2 % osmium tetroxide solution
<i>Replica Methods</i>	
Polyethylene (Seimiya et al., 1970)	Two-stage cellulose acetate-carbon replicas (chromium shadowed) were used to characterise the surface of polyethylene exposed to surface-active reagents
Polyethylene (Robertson, 1969)	Single stage Pt/C replicas (specimen dissolved in hot xylene), and two-stage cellulose acetate Pt/C replicas used to study the surface of stretched polyethylene
<i>trans</i> -1, 4-polyisoprene (Fischer and Henderson, 1967)	Two-stage poly(vinyl alcohol)-carbon replicas (chromium shadowed) were used to study crystallisation
Polytetrafluoroethylene (Koo and Roldan, 1972)	Two-stage gelatin-carbon (Pt-Pd shadowed) replicas were prepared from fatigue fracture surfaces
Polyurethanes (Kuksin et al., 1970)	Films which had been etched in active oxygen were replicated with carbon

9.4 Extraction replica methods for metals

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Al-4wt. %Cu (Cundy et al., 1968)	1. Thin foil rapidly heated to melting point of matrix material. 2. Matrix withdrawn to bars of the specimen grid support. 3. θ-phase precipitates embedded in the thin films of oxide present on the surfaces of the specimen.	
Cu-ThO ₂ (Peterson et al., 1974)	Extraction replicas taken from lapped and ultrasonically cleaned surfaces using an etchant of phosphoric acid and water	
Co-Ni-Cr base alloy containing Nb (Chung and Chaturvedi, 1974)	Carbon extraction replica etched off electrolytically in a 10% sulphuric acid-90% water solution at approx. 4 V	
Co-Ni-Cr-Ti alloy (Chung and Chaturvedi, 1972)	Carbon extraction replicas containing γ' particles were etched off electrolytically in a 10% sulphuric acid-90% methanol solution at approx. 4 V	
Type 316 steel (17%Cr, 11%Ni, 2½%Mo) (Mazza and Willoughby, 1966)	Diamond polishing followed by electropolishing for 30-60 s in the Garofalo solution	
Chromium steels (Mukherjee et al., 1969)	1. Specimen heavily etched (0.6-1% Cr nitral-11.7% Cr; Vilella's reagent) 2. Carefully washed. 3. Shadowed at 50° with Au-40% Pd 4. Vertical carbon deposition. 5. Specimen re-etched in same solution. 6. Specimen rinsed in ethyl alcohol. 7. Replicas stripped in distilled water.	
Austenitic steels containing Ge (Weiner and Froes, 1970)	Selective potentiostatic electroetching in aqueous 20% sulphuric acid was used to distinguish the various phases	
Carbides in stainless steel (Higgins and Roberts, 1966)	<i>Electroetch</i> (to remove carbon replica): 10% oxalic acid 90% water	2 V, 0.1 A/cm ²
Precipitates in Cr-Ni-Co steel (Asbury and Harris, 1966)	<i>Etch</i> : aqua regia immersion. Carbon deposited <i>Electroetch</i> : 20% HCL 80% methanol	
Sulphides in steel (fracture surfaces) (Brammer and Honeycombe, 1964)	Deposit carbon, then etch in: 5% bromine in ethanol Then electroetch in: 10% nitric acid 90% ethanol	0.5-2min 1-1.5 V for approx. 1 s other methods also suggested

MATERIAL AND REFERENCE	METHOD	CONDITIONS
Precipitates in Nb steels (Člhal and Zežek, 1964)	Replicas removed in 5 % solution of bromine in methanol	Fine precipitates extracted using collodion extraction replica technique
Fe–Ni–Nb alloys (Leitch and Chaturvedi, 1971)	<i>Electroetch:</i> carbon evaporated 10 % hydrochloric acid 90 % ethanol	50 V, 5–10 s Carbon film
TaC precipitate in austenitic stainless steels (Froes and Warrington, 1969)	<i>Electropolish:</i> 50ml perchloric acid 950ml acetic anhydride Carbon evaporated onto surface <i>Etch:</i> 25 % HCl 25 % HNO ₃ 50 % glycerine	20 V, 0.1 A/cm ² , < 15°C
Maraging steel (fracture surfaces) (Salmon Cox et al., 1967)	carbon deposited <i>Electroetch:</i> 1 % bromine 99 % methyl alcohol	Extraction fractographs
Complex austenitic alloys (Beattie and Hagel, 1965)	<i>Electroetch:</i> 10 % HCl 90 % water Deposit carbon; immerse in 10 % bromine 90 % methanol	
Cementite in steel (Koréeda and Shimza, 1968)	<i>Etch:</i> 50 % nital (nitric acid/methanol)	
Austenitic steel w/Ti and Al (Silcock and Williams, 1966)	<i>Etch:</i> 1. 10 % HCl in methanol-extracted carbides and some intermetallic particles. 2. 10 % orthophosphoric acid 90 % water extracted γ' -particles only. Carbon deposited <i>Electroetch:</i> perchloric acid/methanol	10 V
AlN precipitates in steel (Dasarathy and Hudd, 1967)	<i>Electroetch:</i> 8 % perchloric acid (5.6 s.g.) 92 % acetic acid followed by <i>Etch:</i> 30 % nital Carbon deposited <i>Stripping:</i> 5 % bromine	55 V
		Store replicas in

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	95 % ethyl alcohol	ethyl or methyl acetate (alcohol dissolves AlN precipitates)
Pb–AuPb ₃ (Rossolimo and Turnbull, 1973)	1. Bulk material was etched in 3 parts glacial acetic acid and 1 part 30 % hydrogen peroxide at 0°C to expose AuPb₃ precipitate particles. 2. Loose precipitate particles were collected from specimen surface using Ladd replicating tape. 3. Tape placed on carbon-coated 200 mesh grid and tape dissolved in acetone, leaving particles on grid.	
Magnesium oxide (Matkin and Bowen, 1965)	1. Carbon evaporated onto dimpled glass microscope slide. 2. Cleaved flake of MgO containing precipitates placed in dimple. 3. MgO matrix dissolved away in dimple with concentrated nitric acid at 50°C.	
TiN precipitate Mo-alloy (Mukherjee and Martin, 1960)	carbon coated: <i>Electroetch:</i> 10ml HCl 4ml HSO ₄ 110ml methanol	4–6 V, ice bath around electrolyte
Rene 41 and Udimet 700 (Wlodek, 1964)	Etching in flowing acid mixture: 150ml H ₂ O 30ml H ₂ SO ₄ 360ml HCl 100ml HNO ₃ 150ml CH ₃ COOH 90gm FeCl ₃ Deposited carbon backed by collodion and stripped	
γ'-precipitate Ni-base alloy (Maniar and James, 1968)	<i>Initial etch:</i> 2 % sulphuric acid 98 % water Carbon coated <i>Etch:</i> 10 % HCl 90 % ethanol	
γ'-precipitate Ni-base alloy (Maniar et al., 1969)	<i>Initial etch:</i> 25 % HCl 25 % HNO ₃ 50 % glycerine	

MATERIAL AND REFERENCE	METHOD	CONDITIONS
	Carbon deposited	Etch which does not attack precipitate:
	<i>Electroetch:</i>	12ml H ₃ PO ₄
	10 % HCl	47ml H ₂ SO ₄
	90 % methanol	41ml HNO ₃
σ -precipitates in Ni-base alloys (Mihalisin et al., 1968)	<i>Etch:</i> 10 % HCl in methanol	
Nb–Zr–Ti alloys (Doi et al., 1968)	<i>Etchant:</i> 5ml HF 10ml H ₂ SO ₄ 10ml H ₂ O ₂ 50ml H ₂ O	
Ti–Al–Zr–W–Si (Imbert, 1974)	1. Bulk material etched in 0.5wt. % hydrofluoric acid solution, bringing precipitates into relief. 2. Carbon replicas were detached in an aqueous solution of 50 % hydrochloric acid	
Precipitates in TiB ₂ (Lynch et al., 1966)	<i>Etch (heavily):</i> 1 part HF 1 part H ₂ SO ₄ Precipitates stripped off with cellulose acetate tape. Tape then carbon coated. Tape dissolved in acetone	
Tungsten–1 %ThO ₂ (Dunham, 1971)	1. Surface ground and electropolished using 5 % sodium hydroxide aqueous solution. 2. Layer of carbon uniformly deposited (100–200Å thick). 3. Tungsten matrix dissolved using dilute sodium hypochlorite. 4. Replicas washed sequentially in acetone, ethanol and distilled water.	

REFERENCES FOR SECTIONS 9.1 TO 9.4

- Abdalla, M. I., Holt, D. B. and Wilcox, D. M. (1973). 'Epitaxial Growth and Structure of CdS Films Evaporated on to Ge', *J. Mat. Sci.* **8**, 590
- Abrahamson, E. P. and Dumais, M. W. (1966). 'An Ordered Structure in Dilute Iron Alloys', *Trans. A.I.M.E.*, **236**, 1743
- Adair, A. M., Hook, R. E. and McCaughey, R. L. (1966). 'The Effect of Thermal History on the Yield Behaviour of Iron', *Trans. A.I.M.E.*, **236**, 174
- Adam, C. McL and Hogan, L. M. (1975). 'Crystallography of the Al–Al₃Fe Eutectic', *Acta Met.*, **23**, 345
- Aeschlimann, R., Gassmann, F. and Woodman, T. P. (1970). 'The Chemical Polishing of Magnesium Aluminate Spinel in Pyrophosphoric acid', *Mat. Res. Bull.*, **5**, 167
- Agrawal, S. P., Sargent, G. A. and Conrad, H. (1974). 'The Microstructure Developed During Extrusion of Titanium Under Hydrostatic Pressure

- at Room Temperature', *Mat. Sci. Eng.*, **14**, 149
- Ahier, S. J. (1970). Ph.D. Thesis, University of Surrey, U.K.
- Ahlers, C. T. J. and Balluffi, R. W. (1967). 'Electropolishing of Platinum Foils at -35°C for Transmission Electron Microscopy', *J. Appl. Phys.*, **38**, 910
- Akhtar, A. (1973). 'Basal Slip in Zirconium', *Acta Met.*, **21**, 1.
- Akutin, M. S., Yu., Budnitskii, M., Aksenov, V. I., Rodivilova, L. A., Kerber, M. L., Kalashnikova, V. G., Berestneva, A. Ya. and Kargin, V. A. (1970). 'Control of the Structure and Properties of Polyarylates During Processing', *Polymer Sci. USSR*, **12**, 3039
- Alcouffe, M., Legros, B. and Lafourcade, L. (1970). *7th Int. Congress for Electron Microscopy, Grenoble*, **1**, 317
- Allpress, J. G. (1969). 'The Direct Observation of Structural Features and Defects in Complex Oxides by Two Dimensional Lattice Imaging', *Mat. Res. Bull.*, **4**, 707
- Allpress, J. G. (1971). 'Electron Microscopy of Lithium Ferrites Precipitation of LiFe_5O_8 in $\alpha\text{-LiFeO}_2$ ', *J. Mat. Sci.*, **6**, 313
- Anantharaman, T. R., Ramaswamy, V. and Butler, E. P. (1974). 'Effect of Matrix Precipitation on Cellular Growth Kinetics in an Al-28at. %Zn Alloy', *J. Mat. Sci.*, **9**, 240
- Anderson, G. W. and Luehrs, F. U. Jr. (1968). 'Structural Characterisation of and Phase Separation in Vanadate Glasses', *J. Appl. Phys.*, **39**, 1634
- Andrews, C. W. and Radcliffe, S. V. (1967). 'Effects of Hydrostatic Pressure on Terminal Structure and Mechanical Behaviour of Beryllium', *Acta Met.*, **15**, 623
- Andrews, E. H. (1964). 'Crystalline Morphology in Thin Films of Natural Rubber II; Crystallisation under Strain', *Proc. Roy. Soc.*, **A277**, 562
- Andrews, E. H. (1966). 'Microfibrillar Textures in Polymer Fibres', *J. Polymer Sci.*, Part A-2 (notes), **4**, 668
- Andrews, E. H. and Reeve, B. (1971). 'Some Structure-Property Relationships in Oriented Polychloroprene', *J. Mat. Sci.*, **6**, 547
- Annarumma, P. and Turpin, M. (1972). 'Structure and High Temperature Mechanical Behaviour of Ni-Ni₃Nb Unidirectional Eutectic', *Met. Trans.*, **3**, 137
- Apple, C. and Krauss, G. (1971). 'Strengthening of an Fe-Ni-V-C Alloy by Cyclic Phase Transformation', *Met. Trans.*, **2**, 1785
- Aqua, E. N. and Owens, C. M. (1967). 'The Microstructural Characterisation of Cold-Rolled Zircaloy-4 Sheet', *Trans. A.I.M.E.*, **239**, 155
- Ardell, A. J. (1969). 'On "Veining" in Electropolished Thin Foils of Supersaturated Ni-Ti Alloys', *Trans. A.I.M.E.*, **245**, 1133
- Ardell, A. J. (1970). 'The Growth of Gamma Prime Precipitates in Aged Ni-Ti Alloys', *Met. Trans.*, **1**, 525
- Ardell, A. J. and Nicholson, R. B. (1966). 'On the Modulated Structure of Aged Ni-Al Alloys', *Acta Met.*, **14**, 1295
- Arko, A. C. and Liu, Y. H. (1971). 'The Effect of Atomic Order on the Hall-Petch Behaviour in Ni₃Fe', *Met. Trans.*, **2**, 1875
- Armond, V. J. and Atkinson, J. R. (1969). 'Chromic Acid as an Etchant for Bulk Polypropylene and its Use to Study (i) Nitric Acid Attack on Polypropylene (ii) Cracks in Polypropylene Induced by Tensile Stress', *J. Mat. Sci.*, **4**, 509
- Aronsson, B. and Grånäs, L. (1971). 'Strain-Rate Sensitivity and Ductile-Brittle Behaviour of Polycrystalline Fe-Si Alloys with 2.5, 3.5 and 4.5 wt. %Si', *Met. Trans.*, **2**, 1087
- Asbury, F. E. and Harris, D. G. (1966). 'Precipitation in a 19 %Cr, 13 %Ni, 10 %Co, Nb, W, Mo Steel', *JISI*, **204**, 497
- Ashbee, K. H. G. (1966). 'Multiple Electron Diffraction: Application to Evaporating UO_{2+y} ', *Phil. Mag.*, **14**, 1031
- Ashbee, K. H. G. and Vassamillet, L. F. (1967). 'Stacking Fault Energies of the Structurally Related Cu-Ga α - and ζ -Phases', *Acta Met.*, **15**, 481
- Ashbee, K. H. G., Smallman, R. E. and Williamson, K. (1964). 'Clustered Vacancy Defects in Rutile', *Proc. British Ceram. Soc.*, **1**, 201
- Ashbee, K. H. G., Vassamillet, L. F. and Massalski, T. B. (1967). 'On the Nature of the Massive Phases in Hypoeutectoid Cu-Ga Alloys', *Acta Met.*, **15**, 181
- van Aswegen, J. S. T., Honeycombe, R. W. K. and Warrington, D. H. (1964). 'Precipitation on Stacking Faults in Cr-Ni Austenitic Steels', *Acta Met.*, **12**, 1
- Ayers, J. D. (1974). 'The Thermally Activated Martensitic Phase Transformation in Ag-Zn', *Acta Met.*, **22**, 611
- Bach, H. (1970). 'Application of Ion Sputtering in Preparing Glasses and their Surface Layers for Electron Microscope Investigations', *J. of Non-Cryst. Solids*, **3**, 1
- Bagley, B. G. and Bair, H. E. (1970). 'Thermally Induced Transformations in Glassy Chalcogenides', *J. Non-Cryst. Solids*, **2**, 155
- Bagley, B. G. and Northover, W. R. (1970). 'Electron Microscope Observations of Thermally Induced Transformations in Amorphous Chalcogenide Thin Films', *J. Non-Cryst. Solids*, **2**, 161
- Bailey, A. and Everett, D. H. (1969). 'Morphology of Poly(vinylidene chloride) and of the Carbons Resulting from its Pyrolysis', *J. Polymer Sci.*, Part A-2, **7**, 87
- Bailey, G. W. (1966). 'Electron Microscopy in

- Petroleum and Petro-chemical Research', *No-relco Reporter*, **XIII**, No. 4
- Bailey, J. E. (1963). 'Electron Microscopy Observations on the Precipitation of Zirconium Hydride in Zirconium', *Acta Met.*, **11**, 267
- Bainbridge, J. E. and Thorne, L. (1970). 'The Preparation of Thin Foils from Sintered Uranium Carbide for Examination by Transmission Electron Microscopy', *J. Nucl. Mat.*, **34**, 202
- Baird, J. D. (1966). 'Precipitation of Nitrides in Iron-Manganese-Nitrogen Alloys', *J.I.S.I.*, **204**, 1122
- Baker, C. (1970). 'The Effect of Heat-treatment and Nitrogen Addition on the Critical Current Density of a Worked Niobium 44wt % Titanium Superconducting Alloy', *J. Mat. Sci.*, **5**, 40
- Baker, C. and Sutton, J. (1969). 'Correlation of Superconducting and Metallurgical Properties of a Ti-20at. %Nb Alloy', *Phil. Mag.*, **19**, 1223
- Baker, R. T. K. and Harris, P. S. (1973). 'Controlled Atmosphere Electron Microscopy Studies of Graphite Gasification. Part I: The Catalytic Influence of Zinc', *Carbon*, **11**, 25
- Baker, T. N. (1973). 'Twins in Iron Alloys Containing Vanadium', *Acta Met.*, **21**, 261
- Balcerzak, A. T. and Sass, S. L. (1972). 'The Formation of the ω -Phase in Ti-Nb Alloys', *Met. Trans.*, **3**, 1601
- Ball, A. and Smallman, R. E. (1965). 'A Note on the Martensitic Transformation in Thin Foils of AuZn', *Acta Met.*, **13**, 1011
- Ball, A. and Smallman, R. E. (1966). 'The Deformation Properties and Electron Microscopy Studies of the Intermetallic Compound NiAl', *Acta Met.*, **14**, 1349
- Ball, A. and Smallman, R. E. (1968). 'Vacancy Defects in the Ordered Compound NiAl', *Acta Met.*, **16**, 233
- Banduryan, S. I. (1970). 'Dependence of the Structure of Vicose Films on the Manufacturing Conditions', *Polymer Sci. USSR*, **12**, 1571
- Banerjee, S. and Krishnan, R. (1973). 'Martensitic Transformation in Zr-Ti Alloys', *Met. Trans.*, **4**, 1811
- Bansal, G. K. and Heuer, A. H. (1972). 'On a Martensitic Phase Transformation in Zirconia (ZrO_2). Part I: Metallographic Evidence', *Acta Met.*, **20**, 1281
- Bapna, W. S., Mori, T. and Meshii, M. (1968). 'The Observation of Slip Channels in Quenched Gold', *Phil. Mag.*, **17**, 177
- Barbee, T. W. Jr. and Huggins, R. A. (1965). 'Dislocation Structures in Deformed and Recovered Tantalum', *J. Less-Common Metals*, **8**, 306
- Barber, D. J. (1970). 'Thin Foils of Non-metals Made for Electron Microscopy by Sputter Etching', *J. Mat. Sci.*, **5**, 1
- Barber, D. J. and Evans, R. G. (1971). 'Crystal Defects in Manganese. Part II: Oxides and Their Influence on Antiferromagnetic Behaviour', *J. Mat. Sci.*, **6**, 1237
- Barber, D. J. and Tighe, N. J. (1965). 'Electron Microscopy and Diffraction of Synthetic Corundum Crystals. Part I: Pure Aluminium Oxide Grown by the Verneuil Process', *Phil. Mag.*, **11**, 495
- Barclay, R. B. and Bonfield, W. (1971). 'Carbon Fibre/Nickel Compatibility', *J. Mat. Sci.*, **6**, 1076
- Barna, A., Barna, P. B. and Bócza, J. F. (1972). 'Crystallisation Processes in α -Ge Thin Films', *J. Non-Cryst. Solids*, **8-10**, 36
- Barnby, J. T. (1966). 'Effect of Strain Ageing on Creep of an A.I.S.I. 316 Austenitic Stainless Steel', *JISI*, **204**, 23
- Barnby, J. T. (1967). 'The Initiation of Ductile Failure by Fractured Carbides in an Austenitic Stainless Steel', *Acta Met.*, **15**, 903
- Barry, T. I., Clinton, D., Lay, L. A., Mercer, R. A. and Miller, R. P. (1969). 'The Crystallisation of Glasses Based on Eutectic Compositions in the System $Li_2O-Al_2O_3-SiO_2$. Part I: Lithium Metasilicate- β -Spodumene', *J. Mat. Sci.*, **4**, 596
- Baubinas, R., Januškevičius, Z., Petretis, B., Sakalas, A. and Viščakas, J. (1973). 'The Influence of Growth Conditions on the Electrical Properties of CdSe Crystals', *Phys. Stat. Sol. (a)*, **15**, 591
- Bay, B. (1970). 'A Quick Method for Producing Thin Foils of Aluminium for Electron Microscopy', *Rev. Sci. Inst.*, **41**, 1668
- Beall, G. H. and Duke, D. A. (1969). 'Transparent Glass-ceramics', *J. Mat. Sci.*, **4**, 340
- Beardmore, P., Davies, R. G. and Johnston, T. L. (1969). 'On the Temperature Dependence of the Flow Stress of Nickel-base Alloys', *Trans. A.I.M.E.*, **245**, 1537
- Beattie, H. J., Jr. and Hagel, W. C., (1965). 'Compositional Control of Phases Precipitating in Complex Austenitic Alloys', *Trans. A.I.M.E.*, **233**, 277
- Beckitt, F. R. and Clark, B. R. (1967). 'The Shape and Mechanism of Formation of $M_{23}C_6$ in Austenite', *Acta Met.*, **15**, 113
- Bell, P. S., and Lewis, M. H. (1971). 'Non-Stoichiometric Vacancy Order in Vanadium Monoxide', *Phys. Stat. Sol. (a)*, **7**, 431
- Benson, R. B. Jr., Dawn, R. K. and Roberts, L. W. Jr., (1968). 'Hydrogen Embrittlement of Stainless Steel', *Trans. A.I.M.E.*, **242**, 2199
- Bernheim, P. and Chaklader, A. C. D. (1971). 'Viscosities of Phase Separated Classes', *J. Non-Cryst. Solids*, **5**, 328
- Bezruk, L. I., Gorokhovskii, G. A. and Lipatov, Yu. S. (1968). 'Improved Gas-discharge Etching Techniques in the Electron Microscope Study of

- Polyamide Structure', *Polymer Sci. USSR*, **10**, 1665
- van der Biest, O. and Thomas, G. (1974). 'Cation Stacking Faults in Lithium Ferrite Spinel', *Phys. Stat. Sol. (a)*, **24**, 65
- Bilde-Sørensen, J. B. (1972). 'Dislocation Structures in Creep-Deformed Polycrystalline MgO', *J. Am. Ceramic Soc.*, **55**, 606
- Billingham, J., Bell, P. S. and Lewis, M. H. (1972). 'A Superlattice with Monoclinic Symmetry Based on the Compound V_6C_5 ', *Phil. Mag.*, **25**, 661
- Billingham, J. and Lewis, M. H. (1971). 'Dislocation Mechanisms for the Nucleation of Transformations in Vanadium Carbide', *Phil. Mag.*, **24**, 231
- Biswas, M. G. A. and Codd, I. (1968). 'An Electron Microscopy Study of Iron-Nitrogen Martensite', *JISI*, **206**, 494
- Blackburn, M. J. (1967). 'Ordering and its Effect on Dislocation Arrangements in Mg_3Cd ', *Trans. A.I.M.E.*, **239**, 660
- Blackburn, M. J. and Nutting, J. (1964). 'Metallography of an Iron-21% Chromium Alloy Subjected to 475°C Embrittlement', *JISI*, **202**, 610
- Blackburn, M. J. and Williams, J. C. (1967). 'The Preparation of Thin Foils of Titanium Alloys', *Trans. A.I.M.E.*, **239**, 287
- Blokland, R. and Prins, W. (1969). 'Elasticity and Structure of Chemically Crosslinked Polyurethanes', *J. Polymer Sci.*, Part. A-2, **7**, 1595
- Bly, D. L., Sherby, O. D., Young, C. M. and Mishchenkov, Y. (1973). 'Influence of Thermal Mechanical Treatments on the Mechanical Properties of a Finely Spheroidised Eutectoid-Composition Steel', *Mat. Sci. Engr.*, **12**, 41
- Bölsing, R., Braun, E., Heuber, U. and Rühle, M. (1969). 'The Preparation of Specimens of Vanadium and Vanadium Alloys for Optical and Electron Microscopy', *Praktische Metallog.*, **6**, 475
- Bonfield, W. (1967). 'Microplasticity in a Cu-1.9wt.% Be Precipitation-Hardening Alloy', *Trans. A.I.M.E.*, **239**, 99
- de Bondt, M. and Deruyttere, A. (1967). 'Pearlite and Bainite Formation in a Cu-16.5at.% Sn Alloy', *Acta Met.*, **15**, 993
- Booker, C. R. and Stickler, R. (1962). 'Method of Preparing Si and Ge Specimens for Examination by Transmission Electron Microscopy', *Br. J. Applied Phys.*, **13**, 446
- Boudevska, H., Fakirov, S. and Aneva, N. (1971). 'Structure Building in Tetracyanoethylene Complexes of Polymers', *J. Mat. Sci.*, **6**, 1136
- Brammer, I. S. and Honeycombe, R. W. K. (1964). 'Formation of Sulphides at Grain Boundaries in Some Pure Iron Alloys', *JISI*, **202**, 335
- Breidis, J. F. (1964). 'Martensitic Transformations in Iron-Chromium-Nickel Alloys', *Trans. A.I.M.E.*, **230**, 1583
- Breinan, E. M., Thompson, E. R. and Tice, W. K. (1972). 'Creep Behaviour of Al-Al₃Ni Eutectic Composites', *Met. Trans.*, **3**, 211
- Bressers, J. and Helbach, P. (1969). 'Preparation of Thin Vanadium Foils for Transmission Electron Microscopy', *J. Phys., E. Sci. Inst.*, **2**, 828
- Brewer, A. W. and Fraikov, F. J. (1967). 'Transmission Electron Microscopy of Pu-1wt.% Ga', *J. Nucl. Mat.*, **21**, 345
- Bricknell, R. H., private communication
- Briers, G. W., Dawe, D. W., Dewey, M. A. P. and Brammar, I. S. (1964). 'A Technique for the Rapid Preparation of Thin Foils for Electron Microscopy from Bulk Materials', *J.I.M.*, **93**, 77
- Bright, M. W. A. and Lewis, M. H. (1971a). 'Controlled Solidification of the Eutectic LiF-MgF₂', *J. Mat. Sci.*, **6**, 1012
- Bright, M. W. A. and Lewis, M. H. (1971b). 'Eutectic Solidification in the NaF-MgF₂ System', *J. Mat. Sci.*, **6**, 1246
- Brimhall, J. L. and Huggins, R. A. (1965). 'Electron Microscopic Observations of Deformed Internally Oxidised Alloys', *Trans. A.I.M.E.*, **233**, 1076
- Brimhall, J. L., Klein, M. J. and Huggins, R. A. (1966). 'Influence of a Finely Dispersed Second Phase on Recrystallisation', *Acta Met.*, **14**, 459
- Brimhall, J. L. and Mastel, B. (1965). 'Effect of Neutron Radiation on Rhenium', *Phil. Mag.*, **12**, 419
- Brinkman, C. R. and Pitt, C. H. (1966). 'The Recrystallisation of 99.997% Chromium', *J. Less-Common Metals*, **11**, 323
- Broom, N. D. and Davies, G. J. (1975). 'Plastic Deformation, Fracture and Dislocation Structures in the Orthorhombic Intermetallic Phase Al₃Ni', *Acta Met.*, **23**, 537
- Bryner, J. S. and Chow, J. G. Y. (1970). 'Fast Neutron Irradiation Effects on Dislocation Structures in Iron Strained at Ambient Temperature', *Acta Met.*, **18**, 191
- Buchanan, E. R. and Reed-Hill, R. E. (1969a). 'The Stress-Strain Behaviour of Magnesium Single Crystals Deformed by Rotational Slip', *Trans. A.I.M.E.*, **245**, 1929
- Buchanan, E. R. and Reed-Hill, R. E. (1969b). 'On the Mechanism of Rotational Slip in Magnesium Single Crystals', *Trans. A.I.M.E.*, **245**, 2547
- Buchi, G. J. P., Page, J. H. R. and Sidey, M. P. (1965). 'Creep Properties and Precipitation Characteristics of 1% Cr-Mo-V Steels', *J.I.S.I.*, **203**, 291
- Buiocchi, C. J. (1967). 'Preparation of [100]-Oriented Foils of GaAs for Transmission Electron Microscopy', *J. Appl. Phys.*, **38**, 1980
- Buls, V. W. and Higgins, T. L. (1970). 'A Particle Growth Theory for Heterogeneous Ziegler Polymerisation', *J. Polymer Sci.*, Part 1-A, **8**, 1037

- Bunton, G. V. (1971). 'The Structure of Some Chalcogenide Glasses', *J. Non-Cryst. Solids*, **6**, 72
- Bunton, G. V., Day, S. C. M., Quilliam, R. M. and Wisbey, P. H. (1971). 'The Preparation and Electrical Properties of Thin Chalcogenide Semiconductor Films', *J. Non-Cryst. Solids*, **6**, 251
- Butler, E. P. and Kelly, P. M. (1968). 'High Damping Capacity Manganese-Copper Alloys. Part 1: Metallography', *Trans. A.I.M.E.*, **242**, 2099
- Butler, E. P. and Thomas, G. (1970). 'Structure and Properties of Spinodally Decomposed Cu-Ni-Fe Alloys', *Acta Met.*, **18**, 347
- Bywater, K. A. and Christian, J. W. (1972). 'Martensitic Transformations in Titanium-Tantalum Alloys', *Phil. Mag.*, **25**, 1249
- Cairns, R. L. (1974). 'Effect of Annealing on Structure and Properties of a Dispersion Strengthened Superalloy, IN-853', *Met. Trans.*, **5**, 1677
- Camanzi, A. (1970). 'A Transmission Electron Microscopy Study of the Effect of Quenched-in Vacancies on Long- and Short-range Order in Cu₃Au Alloy', *Phil. Mag.*, **21**, 649
- Cambini, M. (1970). 'On the Structural and Morphological Relationships Between the VO_x and Vanadium Suboxides in the Two-phase System', *Mat. Res. Bull.*, **5**, 287
- Cambini, M., Pellegrini, G. and Amelinckx, S. (1971). 'Substructure of γ -Vanadium Suboxide Resulting From Long-range Ordering of Oxygen', *Mat. Res. Bull.*, **6**, 791
- Cambini, M., Serneels, R. and Gevers, R. (1974). 'Ordering of Hydrogen in β -Vanadium Hydride Near to V₂H', *Phys. Stat. Sol. (a)*, **21**, K 57
- Campbell, K. and Honeycombe, R. W. K. (1974). 'The Isothermal Decomposition of Austenite in Simple Chromium Steels', *Metal Science*, **8**, 197
- Carpenter, G. J. C. and Walters, J. F. (1973). 'Vacancy Precipitation in Zirconium Alloys', *Acta Met.*, **21**, 1207
- Carpenter, R. W. and Paris, H. G. (1968). 'Preparation of Rhenium for Transmission Electron Microscopy', *J. Appl. Phys.*, **39**, 5809
- Carter, C. B. and Williams, P. M. (1972). 'An Electron Microscopy Study of Intercalation in Transition Metal Dichalcogenides', *Phil. Mag.*, **26**, 393
- Caslavska, V., Strickler, D., Gibbon, D. and Roy, R. (1968). 'Two-liquid Phase Structure of Photoconducting Oxide Glasses', *J. Mat. Sci.*, **3**, 440
- Cass, T. R. and Washburn, J. (1966). 'Dislocation Configuration in Deformed Magnesium Oxide', *Proc. Brit. Ceram. Soc.*, **6**, 239
- Chakravarti, B., Starke, E. A. Jr. and Lefevre, B. G. (1970). 'Order-Induced Strengthening in Ni₄Mo', *J. Mat. Sci.*, **5**, 394
- Chang, H. Y., Viswanadham, R. K. and Wert, C. A. (1974). 'Age Hardening in the V-C and Nb-C Systems', *Met. Trans.*, **5**, 1907
- Chanzy, H. D. and Marchessault, R. H. (1969). 'Spontaneous Catalyst Fracture and its Influence on Nascent Polyethylene Morphology', *Macromolecules*, **2**, 108
- Chanzy, H. D. and Roche, E. J. (1974). 'Cellulose Triacetate Single Crystals Grown from Solution at High Temperature without Inclusion of Solvent', *J. Polymer Sci. P.P.E.*, **12**, 1117
- Charsley, P. and Desvaux, M. P. E. (1966). 'Deformation of Alpha Cu-Al in Stage 1', *Trans. A.I.M.E.*, **236**, 937
- Chaturvedi, M. and Tangri, K. (1969). 'Omega Transformation in Zirconium Alloys', *Trans. A.I.M.E.*, **245**, 259
- Chaudhari, P. and Herd, S. R. (1972). 'Crystallisation of Certain Chalcogenide Glasses', *J. Non-Cryst. Solids*, **8-10**, 56
- Chaudhari, P., Herd, S. R., Ast, D., Brodsky, M. H. and von Gutfeld, R. J. (1972). 'The Structure of Laser Written Lines in a Te₈₁Ge₁₅As₄ Glass', *J. Non-Cryst. Solids*, **8-10**, 900
- Chermant, J. -L., Delavignette, P. and Deschavres, A. (1970). 'Etude des Bandes de Precipitation dans le Carbure de Titane sous Stoechiometrique', *J. Less-Common Metals*, **21**, 89
- Chin, G. Y. (1975). 'On the Microstructure of Extruded Rods and Drawn Wires of Beryllium', *Met. Trans.*, **6A**, 238
- Chung, D. W. and Chaturvedi, M. (1972). 'Quench-ageing Behaviour of 40Co-38Ni-17Cr-5Ti Alloy', *Metal Science J.*, **6**, 134
- Chung, D. W. and Chaturvedi, M. (1974). 'The Precipitation Behaviour of Co-Ni-Cr-Base Alloys Containing Nb', *Metal Science*, **8**, 215
- Clark, H. McL., Merriman, E. A. and Wayman, C. M. (1969). 'Some Characteristics of the β - ζ° and β' - ζ° Transformations in Equiatomic AgZn', *Acta Met.*, **17**, 719
- Clark, J. B. (1965). 'Transmission Electron Microscopy Study of Age-Hardening in a Mg-5wt. %Zn Alloy', *Acta Met.*, **13**, 1281
- Clark, J. B. (1968). 'Age Hardening in a Mg-9wt. %Al Alloy', *Acta Met.*, **16**, 141
- Clauer, A. H., Seltzer, M. S. and Wilcox, B. A. (1971). 'Creep of CoO Single Crystals', *J. Mat. Sci.*, **6**, 1379
- Clauer, A. H., Wilcox, B. A. and Hirth, J. P. (1970). 'Dislocation Substructure Induced by Creep in Molybdenum Single Crystals', *Acta Met.*, **18**, 381
- Člhal, V. and Zežek, J. (1964). 'Some Observations on the Nature of Precipitating Phases in 18/9/Nb Steels', *JISI*, **202**, 124
- Cline, H. E. (1967). 'The Mechanical Properties of the CoAl-Co Eutectic', *Trans. A.I.M.E.*, **239**, 1906
- Clipstone, C. J. and Gaunt, P. (1969). 'Precipitation in Gold-Cobalt Alloys', *Phil. Mag.*, **20**, 173

- Cockayne, D. J. H., Jenkins, M. L. and Ray, I. L. F. (1971). 'The Measurement of Stacking-fault Energies of Pure Face-centred-cubic Metals', *Phil. Mag.*, **24**, 1383
- Comer, J. J. (1967). 'An X-ray and Electron Microscope Study of the Compound $\text{PbAl}_{12}\text{O}_{19}$ ', *Mat. Res. Bull.*, **2**, 293
- Comer, J. J. (1969). 'A Study of Contrast Bands in β -SiC Whiskers', *Mat. Res. Bull.*, **4**, 279
- Conserva, M. and Fiorini, P. (1973). 'Interpretation of Quench-Sensitivity in Al-Zn-Mg-Cu Alloys', *Met. Trans.*, **4**, 857
- Cook, R. F. and Cundy, S. L. (1969). 'Plasmon Energy Losses in Al-Zn Alloys', *Phil. Mag.*, **20**, 665
- Corderoy, D. J. H. and Honeycombe, R. W. K. (1963-64). 'Age-Hardening in Copper-Base Indium Alloys', *J.I.M.*, **92**, 65
- Corey, C. L., Rosenblum, B. Z. and Greene, G. M. (1973). 'The Ordering Transition in Ni_3Al Alloys', *Acta Met.*, **21**, 837
- Corke, N. T., Amelinckx, S. and van Landuyt, J. (1969). 'The Substructure of CuPt Due to Ordering', *Mat. Res. Bull.*, **4**, 289
- Cornelis, I. and Wayman, C. M. (1974). 'Phase Transformations in Metastable β' -CuZn Alloys. Part I: Martensitic Transformations', *Acta Met.*, **22**, 291
- Cornie, J. A., Datta, A. and Soffa, W. A. (1973). 'An Electron Microscopy Study of Precipitation in Cu-Ti Sideband Alloys', *Met. Trans.*, **4**, 727
- Cox, A. R. (1967). 'Metallography and Strengthening Mechanisms of 0.3% C and 0.3% Cr, 1.5% Cu Steels', *JISI*, **205**, 51
- Cox, A. R. (1969). 'Metallography of Copper Steels Containing Silicon and Manganese', *JISI*, **207**, 358
- Cox, M. G. C., McEnaney, B. and Scott, V. D. (1974). 'Phase Interactions in the Growth of Thin Oxide Films on Iron-Chromium Alloys', *Phil. Mag.*, **29**, 585
- Cozar, R. and Pineau, A. (1973). 'Morphology of γ' - and γ -Precipitates and Thermal Stability of Inconel 718 Type Alloys', *Met. Trans.*, **4**, 47
- Crawley, A. F. and Milliken, K. S. (1974). 'Precipitate Morphology and Orientation Relationships in Aged Mg-9%Al-1%Zn-0.3%Mn Alloy', *Acta Met.*, **22**, 557
- Crystal, R. G. (1970). 'The Polymeric Nature of Selenium Crystallisation. Part I: Morphology and Thermodynamic Considerations', *J. Polymer Sci.*, Part A-2, **8**, 1755
- Cundy, S. L. and Grundy, P. J. (1966). 'Combined Electron Microscopy and Energy Analysis of an Internally Oxidised Ni + Si Alloy', *Phil. Mag.*, **14**, 1233
- Cundy, S. L., Metherell, A. J. F. and Whelan, M. J. (1968). 'Microanalysis of Al+4wt.%Cu by Combined Electron Microscopy and Energy Analysis', *Phil. Mag.*, **17**, 141
- Cupschalk, S. G. and Brown, N. (1966). 'Anomalous Contrast from an Anti-phase Domain Boundary in β -Brass', *Phil. Mag.*, **14**, 1077
- Curzon, A. E. and Chlebek, H. G. (1972). 'The Observation of Face Centred Cubic Erbium in Thin Films and its Oxidation', *J. Less-Common Metals*, **27**, 411
- D'Aragona, F. S., Rau, R. C. and Ladd, R. L. (1968). 'Domain Boundaries in Vanadium', *Phys. Stat. Sol.*, **30**, K1
- Das, G. and Mitchell, T. E. (1973). 'Mechanical Properties of Hafnium Single Crystals', *Met. Trans.*, **4**, 1405
- Das, S. K. and Thomas, G. (1974). 'The Metastable Phase Ni_2Mo and the Initial Stages of Ordering in Ni-Mo Alloys', *Phys. Stat. Sol. (a)*, **21**, 177
- Dasarathy, C. and Hudd, R. C. (1967). 'An Example of Secondary Recrystallisation Induced by Aluminium Nitride Precipitation', *Acta Met.*, **15**, 1665
- Dash, B. N. (1970). 'Stacking Fault Energy and Polygonisation in Vapour Grown CdS', *Mat. Res. Bull.*, **5**, 851
- Dash, S. and Brown, N. (1963). 'An Investigation of the Origin and Growth of Annealing Twins', *Acta Met.*, **11**, 1067
- Dash, S. and Brown, N. (1966). 'Nucleation and Growth of Martensite in Fe-32.3% Ni Alloy', *Acta Met.*, **14**, 595
- Davenport, A. T. and Belyakov, B. (1968). 'Applications of the "Universal" Electropolishing Technique to Iron and its Alloys', *JISI*, **205**, 610
- Davies, P. W., Dennison, J. P. and Sidey, D. (1973). 'The Recovery of Mechanical Properties of Nimonic 105 by Heat-treatment after High-temperature Creep', *J. Inst. Met.*, **101**, 153
- Davies, P. W. and Williams, K. R. (1968). 'The Effect of Grain Boundary Cavities on Vacancy Diffusion', *Phil. Mag.*, **18**, 137
- Davies, R. G. and Hellawell, A. (1969). 'The Structure of Directionally Frozen Al-CuAl₂ Eutectic Alloy', *Phil. Mag.*, **19**, 1285
- Davies, R. G. and Stoloff, N. S. (1966). 'A Study of Grain Growth in FeCo-V', *Trans. A.I.M.E.*, **236**, 1605
- Davis, A. R. (1968). 'A Rapid and Routine Technique for the Preparation of Thin-Foil Specimens for Transmission Electron Microscopy', *J.I.M.*, **96**, 61
- Davy, L. G. T., Cochrane, R. C., Collins, M. J. and Glover, S. G. (1966). 'Chemical Thinning Technique for the Preparation of Thin Foils from Bulk Samples of Ferrous Materials', *JISI*, **204**, 1144
- Dawson, C. W. and Sass, S. L. (1970). 'The As-quenched Form of the Omega Phase in Zr-Nb Alloys', *Met. Trans.*, **1**, 2225

- De Ardo, A. J. Jr. and Townsend, R. D. (1970). 'The Effect of Microstructure on the Stress-Corrosion Susceptibility of a High Purity Al-Zn-Mg Alloy in a NaCl Solution', *Met. Trans.*, **1**, 2573
- Deighton, M. (1967). 'Solubility of NbC in 20%Cu-25%Ni Stainless Steel', *JISI*, **205**, 535
- Delaey, J., Sargent, G. A. and Massalski, T. B. (1968). 'On the Duplex Nature and Dislocation Structure of the Massive Cu-Ga Phase', *Phil. Mag.*, **17**, 983
- Delavignette, P. and Amelinckx (1970). 'Precipitation Phenomena in MnO Containing Excess Oxygen', *Mat. Res. Bull.*, **5**, 1009
- Deschanvres, A., Maisseu, A., Nouet, G. and Vicens, J. (1974). 'Morphologies des Nitrures β -Nb₂N et γ -Ta₂N. Relations d'Orientation avec la Matrice α -Nb(N); α -Ta(N)', *J. Less-Common Metals*, **34**, 237
- Detert, K. and Ziebs, J. (1965). 'The Recrystallisation Behaviour of Ni-Ta Alloys and the Role of Fine Precipitates', *Trans. A.I.M.E.*, **233**, 51
- Dexter, S. C. and Greenfield, I. G. (1971). 'Influence of Mechanical Twinning on Wire Texture in an Al-Mg Alloy', *Met. Trans.*, **2**, 181
- Diercks, D. R. and Wert, C. A. (1972). 'An Electron Microscopy Study of Carbide Precipitation in Vanadium', *Met. Trans.*, **3**, 1699
- Dingley, D. J. and Hale, K. F. (1966). 'Burgers Vector of Dislocations in Deformed Iron and Iron Alloys', *Proc. Roy. Soc.*, **A295**, 55
- Dlugosz, J., Folkes, M. J. and Keller, A. (1973). 'Macrolattice Based on a Lamellar Morphology in an SBS Copolymer', *J. Polymer Sci. P.P.E.*, **11**, 929
- Doi, F., Ishida, F., Kawabe, U. and Kitada, M. (1968). 'Critical Current of Superconducting Nb(Cb)-Zr-Ti Alloys in High Magnetic Field', *Trans. A.I.M.E.*, **242**, 1793
- Dollins, C. and Wert, C. (1969). 'Precipitation of Nitrogen on Dislocations in Niobium', *Acta Met.*, **17**, 711
- Doner, M., Chang, H. and Conrad, H. (1974). 'A Comparison of the Dislocation Structures at Small Strains in Copper Deformed in Tension and in Torsion', *Met. Trans.*, **5**, 1383
- Donnet, J. B., Voet, A., Dauksch, H. and Ehrburger, P. (1973). 'Graphitisation in Carbon Fibres Below 1100°C', *Carbon*, **11**, 430
- Douglass, D. L. and van Landuyt, J. (1965). 'The Oxidation of Zirconium: An Electron Microscopy Study of Zirconia Formed in the Thin-film Region', *Acta Met.*, **13**, 1069
- Drobnjak, D. J. and Parr, J. D. (1970). 'Deformation Substructure and Strain-hardening Characteristics of Metastable Fe-Mn Austenites', *Met. Trans.*, **1**, 759
- Duggan, B. J. and Roberts, W. T. (1973). 'Annealing and Precipitation in Iron-1.23wt.%Copper', *Metal Sci. J.*, **7**, 133
- Duhaj, P., Ivan, J. and Makovicky, E. (1968). 'Sigma-phase Precipitation in Austenitic Steels', *JISI*, **206**, 1245
- Duhaj, P., Sládek, V. and Mraško, P. (1973/74). 'Electron Microscopic Study of the Crystallisation Kinetics of the Amorphous Alloy Pd₈₀Si₂₀', *J. Non-Cryst. Solids*, **13**, 341
- Dunham, T. E. (1971). 'Effect of Deformation on ThO₂ Particle Morphology in W-1wt.%ThO₂ Materials', *Met. Trans.*, **2**, 2797
- Dunham, T. E. and Daga, R. L. (1973). 'Recrystallisation of W-1wt.%ThO₂ Wire', *Met. Trans.*, **4**, 175
- Dunlop, G. L. and Taplin, D. M. R. (1972). 'A Metallographic Study of Superplasticity in a Micrograin Aluminium Bronze', *J. Mat. Sci.*, **7**, 316
- Dyson, D. J., Keown, S. R., Raynor, D. and Whiteman, J. A. (1966). 'The Orientation Relationship and Growth Direction of Mo₂C in Ferrite', *Acta Met.*, **14**, 867
- Eades, J. A. (1969). 'The Nature of Black-spot Damage in Irradiated Gold', *Phil. Mag.*, **19**, 47
- Echigoya, J. (1973). 'Dislocation Motion in Antiferromagnetic γ -Fe-Mn Alloys', *Phys. Stat. Sol. (a)*, **17**, 677
- Eckenbach, W., Fuhs, W. and Stuke, J. (1971). 'Preparation and Electrical Properties of Amorphous InSb', *J. Non-Cryst. Solids*, **5**, 264
- Edington, J. W. and Smallman, R. E. (1965). 'Faulted Loops in Quenched Aluminium', *Phil. Mag.*, **11**, 1109
- Edington, J. W. and West, D. R. (1966). 'Three Layer Defects in Quenched Aluminium', *Phil. Mag.*, **14**, 603
- Edmonds, D. V. and Honeycombe, R. W. K. (1973). 'Structure and Properties of an Isothermally Transformed Fe-4Mo-0.2C Alloy', *JISI*, **211**, 209
- Erickson, R. H., Taggart, R. and Polonis, D. H. (1969). 'The Characteristics of Spontaneous Martensite in Thin Foils of Ti-Cr Alloys', *Trans. A.I.M.E.*, **245**, 359
- Essmann, U. and Rapp, M. (1973). 'Slip in Copper Crystals Following Weak Neutron Bombardment', *Acta Met.*, **21**, 1305
- Evans, A. G. and Sharp, J. V. (1971). 'Microstructural Studies on Silicon Nitride', *J. Mat. Sci.*, **6**, 1292
- Evans, E. L., Jenkins, J. L. and Thomas, J. M. (1972). 'Direct Electron Microscope Studies of Graphite Regions in Heat-treated Coals and Coal Extracts', *Carbon*, **10**, 637
- Evans, T. (1963). 'Decomposition of Calcium Fluoride and Strontium Fluoride in the Electron Microscope', *Phil. Mag.*, **8**, 1235

- Evans, W. J. and Wilshire, B. (1970). 'The High Temperature Creep and Fracture Behaviour of 70-30 Alpha-Brass', *Met. Trans.*, **1**, 2133
- Eyre, B. L. and Bartlett, A. F. (1967). 'The Effects of Nickel on the Structure of Sintered Uranium Carbide', *Proc. Brit. Ceram. Soc.*, No.7, 127
- Fawley, R., Quader, M. A. and Dodd, R. A. (1968). 'Compositional Effects on the Deformation Modes, Annealing Twin Frequencies and Stacking Fault Energies of Austenitic Stainless Steels', *Trans. A.I.M.E.*, **242**, 771
- Feeney, J. A. and Blackburn, M. J. (1970). 'Effect of Microstructure on the Strength, Toughness, and Stress-corrosion Cracking Susceptibility of a Metastable Beta Titanium Alloy (Ti-11.5Mo-6Zr-4.5Sn)', *Met. Trans.*, **1**, 3309
- Feltz, A., Büttner, H. J., Lippmann, F. J. and Maul, W. (1972). 'About the Vitreous Systems GeTeI and GeTeSi and the Influence of Microphase Separation on the Semi-conductor Behaviour of Ge-Se Glasses', *J. Non-Cryst. Solids*, **8-10**, 64
- Ferreira-Lima, C. A. and Warminski, T. (1973). 'Comments on KOH Contamination of Ge Crystal Surface', *Phys. Stat. Sol. (a)*, **16**, K93
- Finlayson, T. R. and Milne, I. (1972). 'Metallurgical Variables and Their Influence on the Superconductivity of Niobium-40% Zirconium', *Phil. Mag.*, **25**, 1291
- Fischer, E. and Henderson, J. F. (1967). 'Study of Crystallisation Kinetics of *trans*-1,4-polyisoprene', *J. Polymer Sci. Part A-2*, **5**, 377
- Fisher, R. M. and Marcinkowski, M. J. (1961). 'Direct Observation of Antiphase Boundaries in the AuCu₃ Superlattice', *Phil. Mag.*, **6**, 1385
- Fleck, R. G., Taplin, D. M. R. and Beevers, C. J. (1975). 'An Investigation of the Nucleation of Creep Cavities by 1 MV Electron Microscopy', *Acta Met.*, **23**, 415
- Flewitt, P. E. J. (1974). 'Phase Transformations in Niobium 16 to 40% Zirconium Alloys Above the Monotectoid Temperature: Part I', *Acta Met.*, **22**, 47
- Flewitt, P. E. J. and Palmer, D. E. B. (1973). 'Temperature Dependence of Deformation for β -Phase Niobium 16-40% Zirconium Alloys', *J. Less-Common Metals*, **32**, 57
- Flewitt, P. E. J. and Tate, A. J. (1972). 'Some Structural and Physical Properties of 'As-Cast' Molybdenum-Ruthenium Alloys', *J. Less-Common Metals*, **27**, 339
- Fourdeux, A. and Wronski, A. (1964). 'Some Observations of the Deformation Mechanisms of Niobium', *J. Less-Common Metals*, **6**, 11
- Fourie, J. T., Weinberg, F. and Boswell, F. W. (1960). 'The Growth of Twins in Tin Single Crystals as Observed by Transmission Electron Microscopy', *Acta Met.*, **8**, 851
- Francis, J. M. and Whitlow, W. H. (1965). 'Oxidation of a 20%Cr-25%Ni-Nb Austenitic Steel in Carbon Dioxide at 750 and 850°C', *JISI*, **203**, 468
- Froes, F. H. and Warrington, D. H. (1969). 'The Shape and Strain-Field Associated with Random Matrix Precipitate Particles in Austenitic Stainless Steel', *Trans. A.I.M.E.*, **245**, 2009
- Frohlich, C. R. Jr., Krauss, G. and Bestel, J. L. (1974). 'Coercive Force and Microstructure in a Zr-Permalloy', *Met. Trans.*, **5**, 733
- Furubayashi, E., Endo, H. and Joshida, H. (1974). 'Effects of Prior Plastic Deformation of AlN Precipitates in α -Iron', *Mater. Sci. Eng.*, **14**, 123
- Gai, P. L. and Howie, A. (1974). 'Dissociation of Dislocations in GaP', *Phil. Mag.*, **30**, 939
- Gallagher, P. J. C. and Liu, Y. C. (1969). 'The Diversity of Stacking Fault Energy Determination and its Significance', *Acta Met.*, **17**, 127
- Gallagher, P. J. C. and Washburn, J. (1966). 'The Stacking Fault Energy in the Ag-In Series', *Phil. Mag.*, **14**, 971
- Gal'perin, Ye., Mindrul, V. F. and Smirnov, V. K. (1970). 'Electron-microscopical and Electron-diffraction Study of the Deformation of Thin Films of Spherulitic Polyvinylidene Fluoride', *Polymer Sci. U.S.S.R.*, **12**, 2207
- Garmon, G. and Rhodes, C. G. (1972). 'Structure and Mechanical Properties of the Directionally Solidified Al-Cu-Mg Eutectic', *Met. Trans.*, **3**, 533
- Garmon, G. and Rhodes, C. G. (1974). 'Interfacial Structure of Al-CuAl₂ Eutectic Composites', *Acta Met.*, **22**, 1373
- Garmon, G., Rhodes, C. G. and Spurling, R. A. (1973). 'Crystallography and Morphology of As-grown and Coarsened Al-Al₃Ni Directionally Solidified Eutectic', *Met. Trans.*, **4**, 707
- Garwood, R. D. and Jones, D. H. (1966). 'Electron Microscope Study of the Structure of a 25% Ni-Ti-Al Maraging Steel', *JISI*, **204**, 512
- Gath, J. B., Darling, A. S. and Roberts, E. F. I. (1969). 'The Preparation of Iridium Foils for Transmission Electron Microscopy', *Prakt. Metallog.*, **6**, 228
- Gemperle, A. (1963). 'Preparation of Metal Foils from Deformed Specimens of Small Dimensions for Transmission Electron Microscopy', *Czech. J. Phys.*, **13B**, 62
- Gibbons, T. B. and Hopkins, B. E. (1974). 'High-temperature Ductility of Ni-20%Cr-Base Alloys', *Metal Science*, **8**, 203
- Gidley, J. A. F. and Davies, R. A. (1967). 'A Simple Method of Preparing Thin Metal Foils for Transmission Electron Microscopy', *J. Sci. Instrum.*, **44**, 297
- Ginn, B. J. and Brown, E. D. (1965). 'Electropolishing of Metal Foils with Controlled Potential', *Brit. Weld. J.*, **12**, 90

- Giraud-Heraud, F. and J. Guillaumin, (1973). 'Formation de Phases de Transition dans L'Alliage U-7.5%Nb-2.5%Zr', *Acta Met.*, **21**, 1243
- Gleiter, H. (1969a). 'The Mechanism of Grain Boundary Migration', *Acta Met.*, **17**, 565
- Gleiter, H. (1969b). 'The Migration of Small Angle Boundaries', *Phil. Mag.*, **20**, 821
- Gleiter, H. (1970). 'The Effect of Inclination on Grain Boundary Energies', *Acta Met.*, **18**, 23
- Glenn, R. C. and Duff, W. R. (1965). 'Preparation of Fine Wire for Transmission Electron Microscopy', *Trans. A.S.M.*, **58**, 428
- Glenn, R. C. and Raley, J. C. (1963). 'An Improved Technique for Thinning Metallic Specimens for Transmission Electron Microscopy', *Symp. on Techniques in Electron Metallography*, A.S.T.M. Spec. Tech. Publ. No. **339**, 60
- Godel, D. and Steeb, S. (1968). 'A Method of Preparing Thin Foils of Vanadium for Electron Diffraction Studies or Electron Microscopy', *Prakt. Metallog.*, **5**, 625
- Goringe, M. J. and Valdrè, U. (1964). 'Observation of Solid Neon by Transmission Electron Microscopy', *Phil. Mag.*, **9**, 897
- Goringe, M. J. and Valdrè, U. (1966). 'Transmission Electron Microscopy of Vanadium-Silicon (V_3Si) at Low Temperatures', *Proc. Roy. Soc.*, **A295**, 192
- Grace, F. I., Inman, M. C. and Murr, L. E. (1968). 'Shock-induced Deformation Faults in 70/30 Cu-Zn Alloy', *Brit. J. Appl. Phys.*, **1**, 1437
- Graham, A. H. and Youngblodd, J. L. (1970). 'Work Strengthening by a Deformation-Induced Phase Transformation in "MP Alloys"', *Met. Trans.*, **1**, 423
- Griffiths, C. H. and Sang, H. (1967). 'Extra Reflections in Electron Diffraction Patterns From Polycrystalline and Single Crystal Selenium Films', *Mat. Res. Bull.*, **2**, 515
- Griffiths, D. and Riley, J. N. (1966). 'Dislocation Arrangements in Deformed Polycrystalline 3% Si-Fe', *Acta Met.*, **14**, 755
- Grosskreutz, J. C. (1965). 'Residual Surface Strains in Cyclically Deformed Aluminium and Gold', *Acta Met.*, **13**, 1269
- Grove, C. A. and Judd, G. (1973). 'Effect of Titanium Additions on the Ageing Characteristics of an Al-Zn-Mg Alloy', *Met. Trans.*, **4**, 1023
- Grove, C. A., Judd, G. and Ansell, G. S. (1972). 'Investigation of the Aluminium-Aluminium Oxide Reversible Transformation as Observed by Hot Stage Electron Microscopy', *J. Mat. Sci.*, **7**, 393
- Gulden, M. E. and Nix, W. D. (1968). 'Observations of Dislocation Sources in an Al-Cu-Si Alloy', *Phil. Mag.*, **18**, 217
- Gulden, T. D. and Bernstein, I. M. (1966). 'Dislocation Loops in Irradiated Zirconium', *Phil. Mag.*, **14**, 1087
- Gunwaldsen, D. and Potter, D. (1974). 'A Long Period Superlattice in Dilute Vanadium-Oxygen Alloys', *J. Less-Common Metals*, **34**, 97
- Gupta, S. P., Johnson, A. A. and Mukherjee, K. (1973). 'Stacking Modulated Structures in B_2Ti -Ni Alloys', *Mater. Sci. Engr.*, **11**, 29
- Guttman, V. (1970). 'Keimbildung Bei der Rekristallisation von Molybdän', *J. Less-Common Metals*, **21**, 51
- Gysler, A., Lütjering, G. and Gerold, V. (1974). 'Deformation Behaviour of Age-Hardened Ti-Mo Alloys', *Acta Met.*, **22**, 901
- Habrovec, F., Šharek, J., Rys, P. and Kounicky, J. (1967). 'Rapid Re-austenitising of an Fe-Ni-C Alloy', *JISI*, **205**, 861
- Hacking, R. G., Hockenhull, B. S. and Panakal, J. D. (1969). 'A Simple Technique for the Preparation of Thin Foils in Aluminium and Its Alloys', *J.I.M.*, **97**, 223
- Ham, R. K. and Jaffray, D. (1967). 'Dislocation Multiplication, Vacancy Accumulation and the Onset of Jerky Flow During Forward and Reversed Strain in Cu-3.2at.%Sn', *Phil. Mag.*, **15**, 247
- Ham, R. K., Kirkaldy, J. S. and Plewes, J. T. (1967). 'The Fatigue of Cu-Ni-Fe Alloys', *Acta Met.*, **15**, 861
- Ham, R. K. and Wayman, M. L. (1967). 'The Fatigue and Tensile Fracture of T.D.-Nickel'. *Trans. A.I.M.E.*, **239**, 721
- Ham, R. K. and Wright, M. G. (1964). 'The Effect of Thickness on the Distribution of Dislocations in Cold Rolled Aluminium', *Phil. Mag.*, **10**, 937
- Hammond, C. M. and Ansell, G. S. (1964). 'Gamma-prime Precipitation in an Fe-Ni-Base Alloy', *Trans. A.S.M.*, **57**, 727
- Hampshire, J. M. and Hardie, D. (1974). 'Hardening of Pure Magnesium by Lattice Defects', *Acta Met.*, **22**, 657
- Hancock, J. R. (1968). 'The Effect of Neutron Irradiation on the Loss and Rearrangement of Dislocations in Thin Foils of Fatigue Hardened Copper', *Phil. Mag.*, **18**, 1235
- Hannink, R. H. J. (1970). 'Thin Foil Preparation of Refractory Materials', *Metallography*, **3**, 147
- Hannink, R. H. J., Murray, M. J. and Packer, M. E. (1971). 'Observations on the Domain Structures of V_6C_5 ', *Phil. Mag.*, **24**, 1179
- Hansen, N. (1969a). 'Effect of Grain Size on the Mechanical Properties of Dispersion-Strengthened Aluminium-Aluminium Oxide Products', *Trans. A.I.M.E.*, **245**, 1305
- Hansen, N. (1969b). 'Microstructure and Flow Stress of Aluminium and Dispersion-Strengthened Aluminium-Aluminium Oxide Products Drawn at Room Temperature', *Trans. A.I.M.E.*, **245**, 2061

- Hansson, B. and Barnes, R. S. (1964). 'On Order Twinning in AuCu', *Acta Met.*, **12**, 315
- Hardiman, B., Bucksch, R. and Korczak, P. (1973). 'Observations of Dislocations and Inclusions in Neodymium-doped Yttrium-Aluminium Garnet by Transmission Electron Microscopy', *Phil. Mag.*, **27**, 777
- Harris, J. E. and Masters, B. C. (1966). 'The Annealing of Faulted Loops in Magnesium and Zinc', *Proc. Roy. Soc.*, **A292**, 240
- Harrison, I. R. (1973). 'Polyethylene Single Crystals: Melting and Morphology', *J. Polymer Sci. P.P.E.*, **11**, 991
- Hawbolt, E. B. and Brown, L. C. (1968). 'Massive and Martensitic Transformation in an Ag-Al Alloy', *Trans. A.I.M.E.*, **242**, 1182
- Hawbolt, E. B. and Massalski, T. B. (1970). 'Observations Concerning the β - α_m Massive Transformation in Cu-Zn Alloys', *Met. Trans.*, **1**, 2315
- Hays, C. and Nail, D. A. (1974). 'Transmission Electron Microscopy of Incoloy Alloy 901', *Metallography*, **7**, 59
- Heckmus, G. (1970). 'Simplified Preparation of Thin Films and Foils for T.E.M.', *Metallography*, **3**, 451
- Hede, A. and Aronsson, B. (1969). 'Microstructure and Creep Properties of Some 12%Cr-Martensitic Steels', *JISI*, **207**, 1241
- von Heimendahl, M. (1967). 'Precipitation in Aluminium-Gold', *Acta Met.*, **15**, 144
- von Heimendahl, M. and K. Schneider, (1970). 'Influence of Cold-work on Subsequent Precipitation in an Aluminium-20% Silver Alloy', *J. Mat. Sci.*, **5**, 455
- Hepfer, W. D. (1966). 'Preparation of Thin-film Specimens of Refractory Metals for Transmission Electron Microscopy', *Trans. A.S.M.*, **59**, 345
- Herd, S., Chandari, P. and Brodsky, M. H. (1972). 'Metal Contact Induced Crystallisation in Films of Amorphous Silicon and Germanium', *J. Non-Cryst. Solids*, **7**, 309
- Hess, W. A. and Marsh, P. A. (1965). 'Strain Induced Cavitation in Carbon Black Reinforced Elastomers', *Norelco Reporter*, **XII**, No. 3
- Heuer, A. H., Lally, J. S. Christie, J. M. and Radcliffe, S. V. (1972). 'Phase Transformations and Exsolution in Lunar and Terrestrial Calcic Plagioclases', *Phil. Mag.*, **26**, 465
- Higgins, G. T. (1971). 'The Structure and Annealing Behaviour of Shock-loaded, Cube-orientated Copper', *Met. Trans.*, **2**, 1277
- Higgins, P. R. B. and Roberts, A. C. (1964). 'The Nature and Annealing Behaviour of Fission Fragment Damage in Molybdenum', *J. Less-Common Metals*, **6**, 472
- Higgins, P. R. B. and Roberts, A. G. (1966). 'Carbide Precipitation and Associated Tensile Behaviour in a Neutron Irradiated Stainless Steel', *JISI*, **204**, 489
- Hill, M. J., Holt, D. B. and Unvala, B. A. (1968). 'Automatic Jet Thinning of GaAs for Transmission Electron Microscopy', *J. Phys. E: Sci. Instrum.*, **1**, 301
- Hill, M. J. and Rowcliffe, D. J. (1974). 'Deformation of Silicon at Low Temperatures', *J. Mat. Sci.*, **9**, 1569
- Hing, P. and McMillan, P. W. (1973). 'A Transmission Electron Microscope Study of Glass-ceramics', *J. Mat. Sci.*, **8**, 340
- Hiraga, K. (1973). 'Vacancy Ordering in Vanadium Carbides Based on V_6C_5 ', *Phil. Mag.*, **27**, 1301
- Hirthe, W. M., Melville, A. T. and Wackman, P. H. (1967). 'Preparation of Thin Sections by Ion Bombardment for Transmission Electron Microscopy', *Rev. Sci. Instrum.*, **38**, 223
- Hobson, D. O., Stiegler, J. O. and McHargue, C. J. (1965). 'Twinning in Columbium-Vanadium', *Trans. A.I.M.E.*, **233**, 1138
- Hock, Charles W. (1967). 'Transmission Electron Microscopy of Polypropylene Lamellae Delineated by Staining', *J. Polymer Sci.*, Part A-2, **5**, 471
- Hockey, B. J. (1972). 'Observations by Transmission Electron Microscopy on the Subsurface Damage Produced in Aluminium Oxide by Mechanical Polishing and Grinding', *Proc. Brit. Ceram. Soc.*, **20**, 95
- Holmes, J. J., Robbins, R. E., Brimhall, J. L. and Mastel, B. (1968). 'Elevated Temperature Irradiation Hardening in Austenitic Stainless Steel', *Acta Met.*, **16**, 955
- Holt, D. B. and Dangor, A. E. (1963). 'Direct Observations of the Geometry of Defects in Germanium', *Phil. Mag.*, **8**, 1921
- Holt, B. D., Porter, R. and Unvala, B. A. (1966). 'Thinning Crystals of Semi-conducting Compounds for Transmission Electron Microscopy', *J. Sci. Inst.*, **43**, 371
- Hornbogen, E. and Warlimont, H. (1967). 'Die Bainitische Umwandlung des β -Messings', *Acta Met.*, **15**, 943
- Howie, A. and Swann, P. W. (1961). 'Direct Measurements of Stacking-fault Energies from Observations of Dislocation Nodes', *Phil. Mag.*, **6**, 1215
- Hrivňák, I. (1966). 'Direct Observation of Stress Associated with Nitridic Precipitation in Iron', *JISI*, **204**, 1108
- Hu, H. and Cline, R. S. (1968). 'The Mechanism of Reorientation During Recrystallisation of Polycrystalline Titanium', *Trans. A.I.M.E.*, **242**, 1013
- Hudson, B. (1964). 'The Crystallography and Burgers Vectors of Dislocation Loops in α -Uranium', *Phil. Mag.*, **10**, 949
- Hudson, B. and Makin, M. J. (1965). 'On the Formation of $\{012\}$ Loops in Quenched Aluminium', *Phil. Mag.*, **11**, 423

- Hüther, W. and Reppich, B. (1973). 'Dislocation Structure During Creep of MgO Single Crystals', *Phil. Mag.*, **28**, 363
- Imbert, Y. (1974). 'Creep Resistance and Embrittlement of a Ti-6 %Al-5 %Zr-1 %W-0.4 %Si Alloy', *J. Less-Common Metals*, **37**, 71
- Ingram, P., Williams, J. L., Stannett, V. and Andrews, M. W. (1968). 'Radiation Grafting of Vinyl Monomers to Wool. Part III: Location of the Grafting Polymer', *J. Polymer Sci. Part A-1*, **6**, 1895
- Irani, J. J. and Jones, J. D. (1966). 'Preparation of Thin Foils From Bulk Samples of Ferrous Materials', *JISI*, **204**, 235
- Irwin, G. J. and Otto, B. (1968). 'Some Metallographic Techniques Applied to Molybdenum. Part III: Two Stage Foil Thinning Technique', *Prakt. Metall.*, **5**, 382
- Isaacs, H. S. and Singer, R. M. (1970). 'A Technique for Chemically Polishing Sodium', *J. Nuclear Mat.*, **34**, 197
- Jackson, D. M., Jr. and Howard, R. W. (1965). 'Fabrication of Epitaxial SiC Films on Silicon', *Trans. A.I.M.E.*, **233**, 468
- Jacobs, M. H., Doggett, A. G. and Stowell, M. J. (1974). 'The Microstructure of Al-8wt. %Fe-based Alloys Prepared by Rapid Quenching from the Liquid State', *J. Mat. Sci.*, **9**, 1631
- Jaffrey, D. and Chadwick, G. A. (1969). 'The Lamellar to Fibrous Transition and Orientation Relationships in the Sn-Zn and Al-Al₃Ni Eutectic Systems', *Trans. A.I.M.E.*, **245**, 2435
- de Jager, P. W. G., Kritzinger, S. and Marais, D. J. (1972). 'The Annealing Behaviour of Three- and Four-layer Defects in Quenched Aluminium', *Phil. Mag.*, **25**, 449
- James, P. F. and Keown, S. R. (1974). 'Study of Crystallisation in Lithium Silicate Glasses Using High-voltage Electron Microscopy', *Phil. Mag.*, **30**, 789
- James, P. F. and McMillan, P. W. (1971). 'Transmission Electron Microscopy of Partially Crystallised Glasses', *J. Mat. Sci.*, **6**, 1345
- Jana, S. and Wayman, C. M. (1967). 'Martensite-to-f.c.c. Reverse Transformation in an Fe-Ni Alloy', *Trans. A.I.M.E.*, **239**, 1187
- Jones, A. R. and Ralph, B. (1975). 'The Influence of Recrystallisation on Carbide Particle Distributions in a Fully Stabilised Austenitic Steel', *Acta Met.*, **23**, 355
- Kajiwara, S. and Owen, W. S. (1974). 'The Reversible Martensite Transformation in Iron-Platinum Alloys near Fe₃Pt', *Met. Trans.*, **5**, 2047
- Kambour, R. P. and Holik, A. S. (1969). 'Electron Microscopy of Crazes in Glassy Polymers: Use of Reinforcing Impregnants During Microtomy', *J. Polymer Sci., Part A-2*, **7**, 1393
- Kanamoto, T. (1971). 'Growth and Morphology of Single Crystals of Linear Aliphatic Polyesters', *J. Polymer Sci., Part A-2*, **9**, 2043
- Kear, B. H. and Hornbecker, M. F. (1967). 'Preparation of Oriented Thin Foils of Mar-M200 from Bulk Crystals', *Trans. A.S.M.*, **60**, 644
- Kegg, G. R., Horton, C. A. P. and Silcock, J. M. (1973). 'Grain Boundary Dislocations in Aluminium Bicrystals After High-temperature Deformation', *Phil. Mag.*, **27**, 1041
- Keith, H. D., Padden, F. J. Jr. and Vadimsky, R. G. (1966). 'Intercrystalline Links in Polyethylene Crystallised from the Melt', *J. Polymer Sci., Part A-2*, **4**, 267
- Kelly, P. M. and Blake, R. G. (1973). 'The Characterisation of Dislocation Loops in Neutron Irradiated Zirconium', *Phil. Mag.*, **28**, 415
- Keown, S. R. and Pickering, F. B. (1962). 'A Chemical Thinning Technique for the Preparation of Thin Metal Foils for Transmission Electron Microscopy', *JISI*, **200**, 757
- Killpatrick, D. H. and Young, J. D. (1970). 'Texture and Room Temperature Mechanical Properties of Dispersion Strengthened Ni-Cr Alloys', *Met. Trans.*, **1**, 955
- King, G. W. (1969). 'An Investigation of the Yield Strength of a Dispersion-hardened W-3.8 vol. %ThO₂ Alloy', *Trans. A.I.M.E.*, **245**, 83
- Kinsler, D. L. and Hensch, L. L. (1970). 'Hot Stage Transmission Electron Microscopy of Crystallisation in a Lithia-Silica Glass', *J. Mat. Sci.*, **5**, 369
- Kinsler, D. L., Wilson, L. K., Sanders, H. R. and Hill, D. J. (1972). 'Electrical, Thermal and Structural Properties of As₂Te₃-As₂Se₃ Glasses', *J. Non-Cryst. Solids*, **8-10**, 823
- Kinsman, K. R., Aaronson, H. I. and Eichen, E. (1971). 'The Kinetics and Mechanism of the Thickening of κ -plates in a Cu-Si Alloy', *Met. Trans.*, **2**, 1041
- Kirchner, H. O. (1969). 'Preparation of Electron Microscopy Specimens of Cadmium of Selected Orientation', *J.I.M.*, **97**, 256
- Kirkwood, D. H. (1970). 'Precipitate Number Density in a Ni-Al Alloy at Early Stages of Ageing', *Acta Met.*, **18**, 563
- Kirkwood, D. H. and Nutting, J. (1965). 'An Electron Metallographic Investigation of the Oxidation of Lead Sulphide in Air Between 200 and 350°C', *Trans. A.I.M.E.*, **233**, 708
- Kirman, I. and Warrington, D. H. (1970). 'The Precipitation of Ni₃Nb Phases in a Ni-Fe-Cr-Nb Alloy', *Met. Trans.*, **1**, 2667
- Koch, C. C. and Carpenter, R. W. (1972). 'Precipitates and Fluxoid Pinning in a Superconducting Nb-Hf Alloy', *Phil. Mag.*, **25**, 303
- Koch, C. C., Mardon, P. G. and McHargue, C. J. (1971). 'A Study of the Transformation to the Samarium-type Structure in Gd-Ce Alloys',

- Met. Trans.*, **2**, 1095
- Koch, E. J. and Walter, J. L. (1968). 'The Preparation of Fine Recrystallised Tungsten Wire for Transmission Electron Microscopy', *Trans. A.I.M.E.*, **242**, 157
- Koo, R. C. (1967). 'Evidence for Voids in Annealed Doped Tungsten', *Trans. A.I.M.E.*, **239**, 1996
- Koo, G. P. and Roldan, L. G. (1972). 'Effect of Cyclic Loading on the Morphology of Polytetrafluoroethylene', *J. Polymer Sci.*, Part A-2, **10**, 1145
- Kopetskii, Ch. V. and Pashkoskii, A. I. (1974). 'Plastic Deformation and Dislocation Structure of Molybdenum Single Crystals upon Extending along $\langle 110 \rangle$ and $\langle 100 \rangle$ axes in the Range from 77 to 573K', *Phys. Stat. Sol. (a)*, **21**, 741
- Koréeda, A. and Shimizu, K. (1968). 'Dislocations in Cementite', *Phil. Mag.*, **17**, 1083
- Korshak, V. V. (1970). 'Viscometric and Electron-microscope Study of the Polypyromellitimide of Anilinephthalein', *Polymer Sci. U.S.S.R.*, **12**, 63
- Koskimaki, D., Marcinkowski, M. J. and Sastri, A. S. (1969). 'Solid State Diffusional Transformations in the Near-Equiatomic Ni-Ti Alloys', *Trans. A.I.M.E.*, **245**, 1883
- Kossowsky, R., Johnston, W. C. and Shaw, B. J. (1969). 'Mechanical Properties of Unidirectionally Solidified Ni-Cr Eutectic', *Trans. A.I.M.E.*, **245**, 1219
- Köster, E. H., Thölén, A. R. and Howie, A. (1964). 'Stacking Fault Energies of Ni-Co-Cr Alloys', *Phil. Mag.*, **10**, 1093
- Kotval, P. S. and Honeycombe, R. W. K. (1968). 'An F.C.C.-C.P.H. Transformation in the Cu-Ge System', *Acta Met.*, **16**, 597
- Kotval, P. S. and Nestor, O. H. (1969). 'The Effects of Solute Additions on the Stacking Fault Energy of a Nickel-base Superalloy', *Trans. A.I.M.E.*, **245**, 1275
- Koul, M. K. and Breedis, J. F. (1970). 'Phase Transformations in β -Isomorphous Titanium Alloys', *Acta Met.*, **18**, 579
- Kounický, J. (1968). 'Deformation Twinning in Austenite Fe-Ni-C Alloys at Room Temperature', *Phil. Mag.*, **18**, 205
- Kramer, K. H. (1970). 'Ausscheidungsvorgänge in Rein-Vanadin und Vanadin-Titan Legierungen', *J. Less-Common Metals*, **21**, 365
- Kraševéc, V., Delavignette, P. and Amelinckx, S. (1967). 'Electron Microscopic Observation of Order Twins and Antiphase Boundaries in Tetragonal NiMn', *Mat. Res. Bull.*, **2**, 775
- Kratochvil, P. (1966). 'On the Dislocation Arrangement in Deformed Crystals of Zinc', *Phil. Mag.*, **13**, 267
- Krauss, G., Jr. (1963). 'Fine Structure of Austenite Produced by the Reverse Martensitic Transformation', *Acta Met.*, **11**, 499
- Krishnan, R. V. and Brown, L. C. (1973). 'Martensitic Transformations in β -Ag-Cd Alloys', *Met. Trans.*, **4**, 1017
- Kuksin, A. N., Sergeyeva, L. M., Lipatov, Yu. S. and Bezruk, L. I. (1970). 'Effect of Solid Surfaces on the Supermolecular Structure of Crosslinked Polyurethanes', *Polymer Sci. U.S.S.R.*, **12**, 2643
- Kumar, B., Dennis, M. D. and Rindone, G. E. (1973). 'Boundary Layer in Partially Crystallised Glass', *J. Am. Ceramic Soc.*, **56**, 600
- Kushner, J. B. (1968). 'Improvement in Metal Specimen Preparation for Transmission Electron Microscope Studies', *Rev. Sci. Instr.*, **39**, 128
- Lacefield, K., Moteff, J. and Smith, J. P. (1966). 'Neutron Radiative Damage in Tungsten Single Crystals', *Phil. Mag.*, **13**, 1079
- Lagneborg, R. (1964). 'The Martensite Transformation in 18%Cr-8%Ni Steels', *Acta Met.*, **12**, 823
- Lake, P. B., Meyrick, G. and Hirth, J. P. (1974). 'Dislocation Nodes Observed in Ge Single Crystals Recovery Annealed After Dual Slip Deformation', *Met. Trans.*, **5**, 1761
- Lakso, G. E. and Marcinkowski, M. J. (1969). 'Plastic Deformation Behaviour in the Fe₃Si Superlattice', *Trans. A.I.M.E.*, **245**, 1111
- Lally, J. S. and Partridge, P. G. (1966). 'Observations in Quenched Magnesium', *Phil. Mag.*, **13**, 9
- van Landuyt, J. and Amelinckx, S. (1970). 'Shear Structures in Titanium Oxide', *Mat. Res. Bull.*, **5**, 267
- van Landuyt, J. and Amelinckx, S. (1971). 'Stacking Faults in Silicon Carbide (6H) as observed by Means of Transmission Electron Microscopy', *Mat. Res. Bull.*, **6**, 613
- van Landuyt, J. and Amelinckx, S. (1972). 'Electron Microscope Observations of the Defect Structure of Pyrrhotite', *Mat. Res. Bull.*, **7**, 71
- van Landuyt, J., Remaut, G. and Amelinckx, S. (1969). 'The Electron Microscopic Observation of Ferroelectric Domains and Dislocations in Bi₄Ti₃O₁₂ Single Crystals', *Mat. Res. Bull.*, **4**, 329
- van Landuyt, J., Remaut, G. and Amelinckx, S. (1970). 'Electron Microscope Study of the Substructure of Niobium Ditelluride Single Crystal', *Mat. Res. Bull.*, **5**, 731
- van Landuyt, J., de Ridder, R., Brabers, V. A. M. and Amelinckx, S. (1972). 'Jahn-Teller Domains in MnFe_{3-x}O₄ as Observed by Electron Microscopy', *Mat. Res. Bull.*, **7**, 327
- van Landuyt, J., Vockten, R. and Amelinckx, S. (1970). 'Electron Microscopic Study of the Mixed Oxide (W_{0.35}V_{0.65})₂O₅', *Mat. Res. Bull.*, **5**, 275
- van Landuyt, J. and Wayman, C. M. (1968). 'A Study of Oxide Plate Formation in Tantalum', *Acta Met.*, **16**, 803
- Lapworth, A. J. and Jakubovics, J. P. (1974). 'Effect of Antiphase Boundaries on the Magnetic Prop-

- erties of Cu–Mn–Al Heusler Alloys', *Phil. Mag.*, **29**, 253
- Larson, L. M., Taggart, R. and Polonis, D. H. (1970). 'Ni₃Ta in Nickel-rich Ni–Ta Alloys', *Met. Trans.*, **1**, 485
- Lasalmonie, A. and Martin, J. W. (1974). 'The Deformation Mechanisms of a Unidirectionally Solidified Ni–W Eutectic Alloy', *Acta Met.*, **22**, 1449
- Laughlin, D. E. and Cahn, J. W. (1975). 'Spinodal Decomposition in Age-hardening Copper–Titanium Alloys', *Acta Met.*, **23**, 329
- Lautenschlager, E. P., Tisone, T. C. and Brittain, J. O. (1966). 'Electron Transmission Microscopy of NiAl', *Phys. Stat. Sol.*, **30**, 443
- Leary, D. F. and Williams, M. C. (1973). 'Statistical Thermodynamics of ABA Block Copolymers'. Part II, *J. Polymer Sci. P.P.E.*, **11**, 345
- Leary, D. F., and Williams, M. C. (1974). 'Statistical Thermodynamics of ABA Block Copolymers. Part III: Microstructural Transitions and Model Verification', *J. Polymer Sci. P.P.E.*, **12**, 265
- Lee, D. (1970). 'The Strain Rate Dependent Plastic Flow Behaviour of Zirconium and its Alloys', *Met. Trans.*, **1**, 1607
- Lee, E. U. and Underwood, E. E. (1970). 'Defect Structures and Interactions in Al–Zn Eutectoid Alloys', *Met. Trans.*, **1**, 1399
- Lefevre, B. G., Guy, A. G. and Gould, R. W. (1968). 'Ordering of the K-state in Nickel–Molybdenum Alloys', *Trans. A.I.M.E.*, **242**, 788
- LeHazif, R., Edelin, G. and Depouy, J. M. (1973). 'Diffusion Creep by Dislocation Climb in Beryllium and Be–Cu Single Crystals', *Met. Trans.*, **4**, 1275
- Leitch, K. and Chaturvedi, M. (1971). 'Ageing Behaviour of Fe–30Ni Alloys containing Niobium', *Met. Trans.*, **2**, 1407
- Leombruno, W. J., Haggerty, J. S. and O'Brien, J. L. (1968). 'Structure and Orientation of the Second Phase in ZrB₂ Crystals', *Met. Res. Bull.*, **3**, 361
- Leverant, G. R. and Kear, B. H. (1970). 'The Mechanism of Creep in Gamma Prime Precipitation-hardened Nickel-base Alloys at Intermediate Temperatures', *Met. Trans.*, **1**, 491
- Leverant, G. R. and Sullivan, C. P. (1968). 'The Effect of Dispersed Hard Particles on the High-strain Fatigue Behaviour of Nickel at Room Temperature', *Trans. A.I.M.E.*, **242**, 2347
- Levine, E. and Lütjering, G. (1971). 'Precipitation in the Beryllium–Iron System', *J. Less-Common Metals*, **23**, 343
- Levy, I. S., Mastel, B. and Brimhall, J. L. (1967). 'The Influence of Thermomechanical Treatments on the Microstructure and Tensile Properties of Hastalloy X-280', *Trans. A.I.M.E.*, **239**, 204
- Lewis, M. H. (1966). 'An Electron Microscope Study of Precipitation in MgO Single Crystals', *Phil. Mag.*, **13**, 777
- Lewis, M. H. (1966a). 'Defects in Spinel Crystals Grown by the Verneuil Process', *Phil. Mag.*, **14**, 1003
- Li, J. H. and Uhlmann, D. R. (1970). 'The Flow of Glass at High Stress Levels. Part II: The Effect of Phase Separation on Viscosity', *J. Non-Cryst. Solids*, **3**, 205
- Lilienthal, Z., Mizera, E. and Bartsch, H. (1974). 'Some Remarks on the Real Structure Investigation on ZnTe and CdTe Crystals by Transmission Microscopy', *Phys. Stat. Sol. (a)*, **23**, K115
- Lindborg, U. H. and Averbach, B. L. (1966). 'Crystallographic Aspects of Fracture in Martensite', *Acta Met.*, **14**, 1583
- Ling, Fu-Wen, Starke, E. A. Jr., and Lefevre, B. G. (1974). 'Deformation Behaviour and Texture Development in Beta Ti–V Alloys', *Met. Trans.*, **5**, 179
- Linington, P. F. (1970). 'The Structure of Epitaxial Silicon Films on Sapphire', *7th Int. Congr. Electron Microscopy, Grenoble*, **2**, 447
- Linsky, J. P. (1971). 'Planar Organosilicon Polymers', *J. Polymer Sci.*, Part A-2, **9**, 143
- Liu, C. T. (1973). 'Atomic Ordering and Structural Transformation in the V–Co–Ni Ternary Alloys', *Met. Trans.*, **4**, 1743
- Liu, C. T., Inouye, H. and Carpenter, R. W. (1973). 'Structure and Mechanical Properties of Internally Oxidised Ta–8%W–2%Hf (T-111) Alloy', *Met. Trans.*, **4**, 1839
- Liu, T. S. (1972). 'An Electron Microscopic Study on MnBi Thin Films', *J. Mat. Sci.*, **7**, 559
- Liu, Y. H. (1970). 'The Observation of Deformation Twins in Quenched and Cold-rolled Ni₃Mo', *Mat. Res. Bull.*, **5**, 315
- Liu, Y. H. and Arko, A. C. (1971). 'Dislocation Substructure in As-quenched and Deformed Ni₃Fe Polycrystals', *Met. Trans.*, **2**, 281
- Livak, R. J. and Thomas, G. (1974). 'Loss of Coherency in Spinodally Decomposed Cu–Ni–Fe Alloys', *Acta Met.*, **22**, 589
- Livingston, H. K. and Gregory, R. L. (1971). 'Terephthalamide–Nylon Single Crystals Isolated from Dilute Solutions of Hexafluoro-2, 2-propandiol', *J. Polymer Sci.*, Part A-2, **9**, 2081
- Livingston, J. D., Cline, H. E., Koch, E. F. and Russell, R. R. (1970). 'High-speed Solidification of Several Eutectic Alloys', *Acta Met.*, **18**, 399
- Lloyd, D. J., Chung, D. W. and Chaturvedi, M. C. (1975). 'Serrated Yielding in a Superalloy (40Co–38Ni–17Cr–5Ti)', *Acta Met.*, **23**, 93
- Loesch, H. W. and Brotzen, F. R. (1967). 'Observation of Dislocations in Deformed Molybdenum Crystals', *J. Less-Common Metals*, **13**, 565
- de Luca, R. and Byrne, J. G. (1965). 'An Investigation of the Strengthening of H.C.P. Single Crystals by

- α -Mn Precipitates', *Acta Met.*, **13**, 1187
- Luhman, T. S. and Curzon, A. E. (1972). 'An Electron Diffraction Study of a Ti-22at. %Nb Alloy Containing Unequal Populations of the Four Variants of the ω -phase', *J. Mat. Sci.*, **7**, 710
- Lütjering, G. and Weissman, S. (1970). 'Mechanical Properties and Structure of Age-hardened Ti-Cu Alloys', *Met. Trans.*, **1**, 1641
- Lux, E. and Bollmann, W. (1961). 'On the Mechanism of Carbide Precipitation in Cobalt-base, Heat-resistant Alloys During Age-hardening', *Cobalt*, **12**, 32
- Lynch, C. T., Mersol, S. A. and Vahldiek, F. W. (1966). 'The Microstructure of Single-crystal Titanium Diboride', *J. Less-Common Metals*, **10**, 206
- Mahajan, S. (1973). 'Observations on the Interaction of Twins with Grain Boundaries in Mo-35at. %Re Alloy', *Acta Met.*, **21**, 255
- Mahajan, S., Barry, D. E. and Eyre, B. L. (1970). 'A Thin Twin and its Interaction with a Coherent Twin Boundary in Copper', *Phil. Mag.*, **21**, 43
- Mahajan, S. and Chin, G. Y. (1973). 'Formation of Deformation Twins in F.C.C. Crystals', *Acta Met.*, **21**, 1113
- Maniar, G. N. and James, H. M. (1968). 'Electron Microstructure Study of an Iron-Nickel Base Heat-resistant Alloy Containing Cobalt' in *Fifty Years of Progress in Metallurgical Techniques*, A.S.T.M. Spec. Tech. Pub. No. 430
- Maniar, G. N., Muzyka, D. R. and Whitney, C. R. (1969). 'Microstructural Stability of Pyromet 860 Iron-Nickel-Base Heat Resistant Alloy', *Trans. A.I.M.E.*, **245**, 701
- Mankins, W. L., Hosier, J. C. and Bassford, T. H. (1974). 'Microstructure and Phase Stability of INCONEL Alloy 617', *Met. Trans.*, **5**, 2579
- Marcinkowski, M. J. and Hopkins, E. N. (1968). 'Study of the β - α Transformation in Lanthanum', *Trans. A.I.M.E.*, **242**, 579
- Marcinkowski, M. J. and Poliak, R. M. (1963). 'Variation of Magnetic Structure with Order in the Ni_3Mn Superlattice', *Phil. Mag.*, **8**, 1023
- Marcinkowski, M. J., Sastri, A. S. and Koskinaki, D. (1968). 'Martensitic Behaviour in the Equiatomic Ni-Ti Alloy', *Phil. Mag.*, **18**, 945
- Marder, A. R., (1969). 'The Effect of Carbon Content, Test Temperature and Strain Rate on the Strain Rate Sensitivity of Fe-C Alloys', *Trans. A.I.M.E.*, **245**, 1337
- Martin, I. G. (1969). 'Deformation of Irradiated Polyethylene Crystals', Ph.D. Thesis, Queen Mary College, Univ. of London
- Maruno, S. and Noda, M. (1972). 'Microstructure of Glasses in the System As_2S_x with $x < 3$ ', *J. Non-Cryst. Solids*, **7**, 1
- Mastel, B. and Brimhall, J. L. (1965). 'The Combined Effect of Carbon and Neutron Radiation on Molybdenum', *Acta Met.*, **13**, 1109
- Matkin, D. I. and Bowen, D. H. (1965). 'Whisker Growth within Single Crystals of Magnesium Oxide', *Phil. Mag.*, **12**, 1209
- Matsuura, K., Tsukamoto, M. and Watanabe, K. (1973). 'The Work-hardening of Cu-Fe Alloy Single Crystals Containing Iron Precipitates', *Acta Met.*, **21**, 1033
- Matthes, H., Bialas, D. and Hesse, J. (1970). 'Electron Microscopic Observations on the Phase Transformation in Sintered Iron Disilicide', *J. Mat. Sci.*, **5**, 181
- Mazey, D. J. and Barnes, R. S. (1968). 'Platelets of Interstitial Atoms in Proton-irradiated Copper', *Phil. Mag.*, **17**, 387
- Mazza, J. A. and Willoughby, G. (1966). 'Structural Changes and Creep Mechanisms in Type 316 Steel at 600°C', *JISI*, **204**, 718
- McDonald, R. C. and Ardell, A. J. (1973). 'On Diffraction Contrast Effects at Extrinsic Grain Boundary Dislocations', *Phys. Stat. Sol. (a)*, **18**, 407
- McLaren, A. C. and Phakey, P. P. (1965). 'A Transmission Electron Microscope Study of Amethyst and Citrine', *Aust. J. Phys.*, **18**, 135
- McMaster, A. D. and Fuschillo, N. (1970). 'Semiconductor Behaviour in Amorphous Au-SiO Thin Films', *J. Non-Cryst. Solids*, **2**, 307
- McMillan, P. W., Phillips, S. V. and Partridge, G. (1966). 'The Structure and Properties of a Lithium Zinc Silicate Glass-Ceramic', *J. Mat. Sci.*, **1**, 269
- Meieran, E. S. and Thomas, D. A. (1963). 'Preparation of Wires for Examination by Transmission Electron Microscopy', *Trans. A.I.M.E.*, **227**, 284
- Melmed, A. J. and Carroll, J. J. (1973). 'Field-ion Microscopy of Osmium', *J. Less-Common Metals*, **30**, 199
- Melton, K. N. and Edington, J. W. (1973). 'Superplasticity in Extruded Zn-40wt. %Al and Zn-50wt. %Al Alloys', *Metal Science J.*, **7**, 172
- Melton, K. N. and Edington, J. W. (1974). 'Discontinuous Reactions in an Aluminium-29at. %Zinc Alloy', *Acta Met.*, **22**, 1457
- Mencik, Z., Plummer, H. K. and van Oene, H. (1972). 'Confined-growth Crystallisation of Polyethylene', *J. Polymer Sci.*, Part A-2, **10**, 507
- Merli, P. G. and Valdrè, U. (1972). 'New Simple Methods for Jet Cutting and for Simultaneous Thinning and Cutting of Disc Specimens for Electron Microscopy', *J. Phys., E. Sci. Inst.* **5**, 933
- Mersol, S. A., Vahldiek, F. W. and Lynch, C. T. (1966). 'Veining Substructure in Single-crystal Dimolybdenum Carbide', *J. Less-Common Metals*, **10**, 373
- Meulemans, M., Delavignette, F., Carcia-Gonzales, and Amelinckx, S. (1970). 'Regular Network of Anti-phase Boundaries in the χ -Phase of the

- System Fe–Cr–Mo–Ti', *Mat. Res. Bull.*, **5**, 1025
- Michel, D. J., Moteff, J. and Lovell, A. J. (1973). 'Substructure of Type 316 Stainless Steel Deformed in Slow Tension at Temperatures Between 21 and 816°C', *Acta Met.*, **21**, 1269
- Michell, D., Morton, A. J. and Smith, A. P. (1971). 'The Dislocation Structure of Single Crystals of γ -Brass', *Phys. Stat. Sol. (a)*, **5**, 341
- Michels, H. T., Cadoff, I. B. and Levine, E. (1972). 'Precipitation-hardening in Cu–3.6wt. %Ti', *Met. Trans.*, **3**, 667
- Michels, L. C. and Rickets, B. G. (1967). 'Nucleation of Recrystallisation in Cold-worked Aluminium and Nickel', *Trans. A.I.M.E.*, **239**, 1841
- Mihalisin, J. R., Bieber, C. J. and Grant, R. T. (1968). 'Sigma—Its Occurrence, Effect and Control in Nickel-base Super Alloys', *Trans. A.I.M.E.*, **242**, 2399
- Miller, G. P. and Mitchell, W. I. (1965). 'Structure and Hardening Mechanisms of 18 %Ni–Co–Mo Maraging Steels', *JISI*, **203**, 899
- Milne, I. (1972). 'Evidence for the Control of the Critical Current Density of Nb–25 %Zr Superconducting Wires by the Dislocation Substructure', *J. Mat. Sci.*, **7**, 413
- Mishima, G. and Shiromizu, R. (1968). 'Discontinuous Precipitation in Cu–1.79wt. %Be', *Trans. A.I.M.E.*, **242**, 751
- Mitchell, R., Paris, H. G. and LeFevre, B. G. (1973). 'Ordering Hardening in Equiatomic CuPt', *Met. Trans.*, **4**, 833
- Miyamoto, T., Kodama, K. and Shibayama, K. (1970). 'Structure and Properties of a Styrene–Butadiene–Styrene Block Copolymer', *J. Polymer Sci.*, Part A-2, **8**, 2095
- Molcik, M. (1970). 'The Production of Thin Metal Foils for Electron Microscopy by Ion Bombardment', *Prakt. Metallog.*, **7**, 361
- Moon, D. M. and Stickler, R. (1967). 'Thinning of Bismuth Telluride (Be_2Te_3) Specimens for Transmission Electron Microscopy', *Praktische Metallog.*, **4**, 89
- Moreen, H. A., Taggart, R. and Polonis, D. H. (1974). 'The Formation of Modulated Structures in Ni–V Alloys', *Met. Trans.*, **5**, 79
- Morgan, G. and Lewis, M. H. (1974). 'Hardness Anisotropy in Niobium Carbide', *J. Mat. Sci.*, **9**, 349
- Morgan, R., Faulkner, R. G. and Ralph, B. (1966). 'Electropolishing Apparatus for Comparative Field-ion and Electron Microscopy', *JISI*, **204**, 943
- Mori, T. and Meshii, M. (1969). 'Plastic Deformation of Quench-hardened Aluminium Single Crystals', *Acta Met.*, **17**, 167
- Morris, D. G., Besag, F. M. C. and Smallman, R. E. (1974). 'Ordering and Disordering in Cu_3Au ', *Phil. Mag.*, **29**, 43
- Morrow, D. R., Richardson, G. C., Kleinman, L. and Woodward, A. E. (1967). 'Annealing and Melting of Poly-4-methylpentene-1 Single Crystals', *J. Polymer Sci.*, Part A-2, **5**, 493
- Morton, A. J. and Wayman, C. M. (1966). 'Theoretical and Experimental Aspects of the "(225)" Austenite–Martensite Transformation in Iron Alloys', *Acta Met.*, **14**, 1567
- Moskovic, R. (1973). Private communication
- Moss, S. C. and Flynn, P. (1973). 'Impurity Effects on the Structure Of Amorphous Silicon and Germanium Prepared in Various Ways', *Phil. Mag.*, **27**, 441
- Moss, S. C. and de Neufville, J. P. (1972). 'Thermal Crystallisation of Selected Te-based Sputtered Thin Films', *J. Non-Cryst. Solids*, **8–10**, 45
- Moynihan, C. T., Macedo, P. B. Aggarwal, I. D. and Schnaus, U. E. (1971). 'Direct Observation of the Double Glass Transition in a Phase-separated Glass', *J. Non-Cryst. Solids*, **6**, 322
- Mufti, A. R. and Holt, P. B. (1972). 'Epitaxial Growth and Structure of ZnTe Evaporated onto Ge in Vacuum', *J. Mat. Sci.*, **7**, 694
- Mukherjee, A. K. and Martin, J. W. (1960). 'Hardening of a Molybdenum Alloy by Nitride Dispersions', *J. Less-Common Metals*, **2**, 392
- Mukherjee, A. K. and Martin, J. W. (1963). 'The Effect of Nitriding upon the Creep Properties of Some Molybdenum Alloys', *J. Less-Common Metals*, **5**, 403
- Mukherjee, T., Stumpf, W. E., Sellars, C. M. and Tegart, W. J. McG. (1969). 'Kinetics of Coarsening of Carbides in Chromium Steels at 700°C', *JISI*, **207**, 621
- Mulford, R. A. and Pope, D. P. (1973). 'The Yield Stress of $\text{Ni}_3(\text{Al}, \text{W})$ ', *Acta Met.*, **21**, 1375
- Murr, L. E. (1973). 'Twin Boundary Energetics in Pure Aluminium', *Acta Met.*, **21**, 791
- Murr, L. E. (1974). 'Note on the Electropolishing of Iridium Foils for Transmission Electron Microscopy—Some Additional Techniques', *J. Less-Common Metals*, **34**, 177
- Murr, L. E., Smith, P. J. and Gilmore, C. M. (1968). 'Relative Interfacial Free Energies in Pure Nickel, Dispersion Hardened Nickel and a Precipitation Hardened Nickel-base Alloy', *Phil. Mag.*, **17**, 89
- Mushovic, J. N. and Stoloff, N. S. (1969). 'Precipitation Processes in a Mg–Th–Zr Alloy', *Trans. A.I.M.E.*, **245**, 1449
- Myers, M. B. and Berkes, J. S. (1972). 'Phase Separation in Amorphous Chalcogenides', *J. Non-Cryst. Solids*, **8–10**, 804
- Naimark, N. I., Vasil'ev, B. V., Zaspink, G. S., Shcherbakova, N. G., Landysheva, V. A. and Lozhkin, V. Ye. (1970). 'Effect of Graft-copolymer on the Structure and Behaviour of Solid Mixtures of Cellulose Acetate and Polyacrylonitrile', *Polymer Sci. U.S.S.R.*, **12**, 1865

- Nakagawa, K. and Izumitani, T. (1972). 'Metastable Phase Separation and Crystallisation of $\text{Li}_2\text{O}-\text{Al}_2\text{O}_3-\text{SiO}_2$ Glasses: Determination of Miscibility Gap from the Lattice Parameters of Precipitated β -quartz Solid Solution', *J. Non-Cryst. Solids*, **7**, 168
- Narayan, J. (1973). 'Subgrain Boundaries in MgO ', *J. Am. Ceramic Soc.*, **56**, 644
- Narayanan, G. H. and Copley, S. M. (1974). 'Anomalous Diffraction Effects in Gallium Arsenide Single Crystals', *Phys. Stat. Sol. (a)*, **23**, 123
- Naziri, H. and Pearce, R. (1973). 'Some Observations on the Behaviour of Superplastic Zinc-Aluminium Eutectoid over a Wide Range of Strain Rates', *JIM*, **101**, 197
- Naziri, H. and Pearce, R. (1974). 'Superplasticity in a $\text{Zn}-0.4\% \text{Al}$ Alloy', *Acta Met.*, **22**, 1321
- Naziri, H., Pearce, R., Henderson Brown, M. and Hale, K. F. (1975). 'Micro-Structural-Mechanism Relationship in the Zinc Aluminium Eutectoid Superplastic Alloy', *Acta Met.*, **23**, 489
- Naybour, R. D. (1965). 'Hardening During Deformation of an $18\text{Cr}/12\text{Ni}/\text{Nb}$ Austenitic Steel at 650°C ', *Acta Met.*, **13**, 1197
- Nembach, E. and Tachikawa, K. (1969). 'An Electron Microscope Investigation of the Flux Pinning Centres in Superconducting V_3Ga Tapes', *J. Less-Common Metals*, **19**, 359
- Newman, R. W. and Hren, J. J. (1971). 'Secondary Defects in Quenched and Aged Platinum', *Met. Trans.*, **2**, 1129
- Nissan, S. I. and Hornstein, F. (1974). 'Electropolishing of Tin Bearing Invar Alloys', *Metallography*, **7**, 171
- Nolder, R. L. and Thomas, G. (1964). 'The Substructure of Plastically Deformed Nickel', *Acta Met.*, **12**, 227
- Nordstrom, T. V. and Barrett, C. R. (1969). 'The Stacking Fault Energy of Some Copper-Silicon Alloys', *Acta Met.*, **17**, 139
- Nordstrom, T. V. and Barrett, C. R. (1972). 'Flow-Stress Recovery of Nickel-Aluminium Alloys', *J. Mat. Sci.*, **7**, 1037
- Nuttall, K. and Nicholson, R. B. (1968). 'Microstructure of Superplastic Alloys', *Phil. Mag.*, **17**, 1087
- Obara, T., Yoshinga, H. and Morozumi, S. (1973). ' $\{11\bar{2}2\} < \bar{1}123 >$ Slip System in Magnesium', *Acta Met.*, **21**, 845
- Ogawa, K. (1966). 'Transmission Electron-Microscopic Studies on Mechanism for Dipole Formation in MgO ', *Phil. Mag.*, **14**, 619
- Ogawa, K. and Maddin, R. (1964). 'Sigma Phase Precipitates in $\text{Mo}-\text{Re}$ Alloys', *Acta Met.*, **12**, 1161
- Ohlidal, M. and Orel, V. (1974). 'Preparation of Ion-implanted Silicon for Transmission Electron Microscopy', *Czechoslov. J. Physics*, **B 24**, 349
- Oka, M., Lee, C. S. and Shimizu, K. (1972). 'Transmission Electron Microscopy Study of Face-centered Orthorhombic Martensite in $\text{Ti}-12.6\% \text{V}$ Alloy', *Met. Trans.*, **3**, 37
- Okamoto, P. R. and Thomas, G. (1967). 'Dislocation Substructure in Single Crystals of Hexagonal $\text{Ag}-\text{Al}$ Oriented for Prismatic Slip', *Acta Met.*, **15**, 1325
- Olsen, R. J., Judd, G. and Ansell, G. S. (1971). 'Measurement of Particle-Matrix Interface Strength in T. D.-Nickel', *Met. Trans.*, **2**, 1353
- Orlova, A. and Čadek, J. (1970). 'On the Origin of the Dislocation Substructure During High-temperature Creep', *Phil. Mag.*, **21**, 509
- den Ouden, G. (1969). 'Electron Microscope Observation of Neutron-Irradiated Germanium', *Phil. Mag.*, **19**, 321
- Ozel, M. and Nutting, J. (1969). 'Plastic Deformation and Recrystallisation of TiC Particles During Creep of an Austenitic Steel', *JISI*, **207**, 92
- Parker, B. A. (1972). 'On the Enhanced Small-angle Scattering from Polished Surfaces of Aluminium', *J. Appl. Cryst.*, **5**, 372
- Parkins, R. A. and Haney, E. G. (1968). 'Stress Corrosion Cracking of $18\% \text{Ni}$ Maraging Steel in Acidified Sodium Chloride Solution', *Trans. A.I.M.E.*, **242**, 1943
- Parsons, J. R., Rainville, M. and Hoelke, C. W. (1970). 'Influence of Crystalline Defects in 2-beam Crystal Lattice Images—Experimental', *Phil. Mag.*, **21**, 1105
- Pascover, J. S. and Radcliffe, S. V. (1969). 'Effects of Pressure on Phase Equilibria and Transformation in the Iron-Chromium System', *Acta Met.*, **17**, 321
- Pashley, D. W., Rhodes, J. W. and Sindorek, A. (1966). 'Delayed Ageing in $\text{Al}-\text{Mg}-\text{Si}$ Alloys: Effect on Structure and Mechanical Properties', *JIM*, **94**, 41
- Pashley, D. W., Robertson, J. L. and Stowell, M. J. (1969). 'The Deformation of CuAlI ', *Phil. Mag.*, **19**, 83
- Patel, A. R. and Mysorewala, D. V. (1970). 'Effect of Temperature and Pressure on the Thermal Oxidation Behaviour of β -Sn Films', *Mat. Res. Bull.*, **5**, 1031
- Patrician, T. J., Ledbetter, H. M. and Reed, R. P. (1972). 'On the Apparent Rotation of Transformation Twins in $\text{Fe}-\text{Ni}$ Martensites', *Met. Trans.*, **3**, 947
- Peacock, R. F. (1973). Ph.D. Thesis, University of Cambridge
- Pelleg, J. (1967). 'Electropolishing Niobium', *J. Less-Common Metals*, **12**, 421
- Pelleg, J. (1974). 'Electropolishing of Titanium', *Metallography*, **7**, 357
- Pellier, L. (1963). 'Some Observations on the Effect

- of Sensitisation at 1200°F on the Electron Microstructure of a Type-304 Stainless Steel with an Extra High Carbon Content', *Trans. A.I.M.E.*, **227**, 422
- Perkins, A. J., Yaffe, P. E. and Hehemann, R. F. (1970). 'The Athermal Omega Transformation in Zr-Nb Alloys', *Met. Trans.*, **1**, 2785
- Perrow, J. M., Smeltzer, W. W. and Emburry, J. D. (1968). 'The Role of Structure Defects in the Growth of Nickel Oxide Films', *Acta Met.*, **16**, 1209
- Perrow, J. M., Smeltzer, W. W. and Ham, R. K. (1967). 'On the Nature of Short-circuit Diffusion Paths in Nickel Oxide Films', *Acta Met.*, **15**, 577
- Petermann, J. and Gleiter, H. (1973a). 'The Molecular Structure of Molten Polyethylene Films', *Phil. Mag.*, **28**, 271
- Petermann, J. and Gleiter, H. (1973b). 'Drawing of Fibres from Irradiated Polyethylene Single Crystals', *J. Polymer Sci. P.P.E.*, **11**, 359
- Peterson, L. G., Kimmel, E. R. and Queeney, R. A. (1974). 'Thermomechanical Proccession, Microstructure and Properties of a Copper 1.0vol. % ThO₂ Alloy', *Mat. Sci. Eng.*, **16**, 107
- Petroff, P., and Jouffrey, B. (1969). 'Electron Microscopy Observations of the Dislocation Structure in Lithium Crystals', *Appl. Phys. Letters*, **14**, 366
- Petrov, M. D., (1973). 'Elektronenmikroskopische Untersuchung über den Kiembildungsmechanismus bei der Rekristallisation von Verformtem Technisch Reinem Kupfer', *Metallography*, **6**, 445
- Petrovic, J. J. and Ebert, L. J. (1972). 'An Electron Microscopy Examination of Primary Recrystallisation in TD-Nickel', *Met. Trans.*, **3**, 1123
- Phaal, C. and Zuidema, G. (1966). 'Transmission Electron Microscopy of Synthetic Diamond', *Phil. Mag.*, **14**, 79
- Phillips, S. V., Booth, R. E. and McMillan, P. W. (1970a). 'Structure and Electrical Properties of Chalcogenide Glasses', *Proc. Brit. Ceramic Soc.*, No. 18, 293
- Phillips, S. V., Booth, R. E. and McMillan, P. W. (1970b). 'Structural Changes Related to Electrical Properties of Bulk Chalcogenide Glasses', *J. Non-Cryst. Solids*, **4**, 510
- Phillips, V. A. (1963). 'New Evidence for Segregation at Grain Boundaries, Subgrain Boundaries and Dislocation in Dilute Iron-Carbon-Nitrogen Alloys', *Acta Met.*, **11**, 1139
- Phillips, V. A. (1966). 'Electron Microscope Observations on Moiré Fringes and Interfacial Dislocations at Cobalt Precipitates in Copper', *Acta Met.*, **14**, 271
- Phillips, V. A. (1966a). 'Effect of Particles in Cu-3.23wt. %Co Alloy on the Annealing Behaviour after Heavy Rolling', *Trans. A.I.M.E.*, **236**, 1302
- Phillips, V. A. (1966b). 'A Metallographic Study of Precipitation in a Ni-12.7at. %Al Alloy', *Acta Met.*, **14**, 1533
- Phillips, V. A. (1967). 'Effect of Coherent Gamma Prime (Ni₃Al) Particles on the Annealing of Rolled Ni-12.7at. %Al Alloy', *Trans. A.I.M.E.*, **239**, 1955
- Phillips, V. A. (1973). 'Lattice Resolution Measurement of Strain Fields at Gunier Preston Zones in Al-3.0 %Cu', *Acta Met.*, **21**, 219
- Phillips, V. A. (1974). 'Electron Microscope Observations on Precipitation in a Cu-1.07 %Zr Alloy', *Metallography*, **7**, 137
- Phillips, V. A. and Hugo, J. A. (1970). 'The Resolution of Lattice Planes and Lattice Defects in Semiconductors Including Observations on Boundaries', *Acta Met.*, **18**, 123
- Phillips, V. A. and Seybolt, A. U. (1968). 'A Transmission Electron Microscopic Study of Some Ion-nitrited Binary Iron Alloys and Steels', *Trans. A.I.M.E.*, **242**, 2415
- Phillips, V. A. and Tanner, L. E. (1973). 'High Resolution Electron Microscope Observations on GP Zones in an Aged Cu-1.97wt. %Be Crystal', *Acta Met.*, **21**, 441
- Pike, T. J. and Noble, B. (1973). 'The Formation and Structure of Precipitates in a Dilute Magnesium-Neodymium Alloy', *J. Less-Common Metals*, **30**, 63
- Pinnel, M. R. and Lawley, A. (1968). 'Preparation of Electron Transparent Metal-Matrix Composites', *Proc. Elec. Microscopy Soc. of Am.*, 26th Annual Meeting, 334
- Pinto, R. (1971). 'Structural Transformations in the Chalcogenide Systems Ge-As-Te and Ge-As-Se', *J. Non-Cryst. Solids*, **6**, 187
- Pittinato, G. F. and Frederick, S. F. (1969). 'Deformation Modes of Ti-5Al-2.5Sn under Uniaxial and Biaxial Stresses at 20K', *Trans. A.I.M.E.*, **245**, 2299
- Popplewell, J. M. and Crane, J. (1971). 'Order-strengthening in Cu-Al Alloys', *Met. Trans.*, **2**, 3411
- Potter, D. and Altstetter, C. (1971). 'Ordering of Interstitial Nitrogen in Vanadium', *Acta Met.*, **19**, 881
- Prewo, K. and McCarthy, G. (1972). 'Interfacial Characteristics of Silicon-carbide-coated Boron-reinforced Aluminium Matrix Composites', *J. Mat. Sci.*, **7**, 919
- Price, R. J. (1974). 'High-temperature Neutron Irradiation of Highly Oriented Carbons and Graphites', *Carbon*, **12**, 159
- Pumphrey, P. H. and Edington, J. W. (1974). 'The Structure of the Semicohere Interface Between Grain Boundary Nucleated M₂₃C₆ and Austenitic Stainless Steel', *Acta Met.*, **22**, 89
- Puttick, K. E. and Rudman, M. R. (1970). 'Prepara-

- tion of Damage-free Thin Films from a Single Crystal of Cadmium', *7th Int. Congr. Electron Microscopy, Grenoble*, **1**, 315
- Quader, M. A. and Dodd, R. A. (1968). 'The Structure of Quenched and Aged Gold, Gold-Cadmium and Gold-Zinc Alloys', *Phil. Mag.*, **17**, 575
- Rack, H. J. and Cohen, M. (1970). 'Preparation of Transverse Sections of Heavily Drawn Wires for Transmission Electron Microscopy', *Met. Trans.*, **1**, 1050
- Raffo, P. L. (1970). 'Dynamic Strain Ageing in Carbide-strengthened Molybdenum Alloys', *Met. Trans.*, **1**, 835
- Raffo, P. L. and Mitchell, J. E. (1968). 'Yielding, Work Hardening and Cleavage in Tantalum-Rhenium Alloy Single Crystals', *Trans. A.I.M.E.*, **242**, 907
- Raghavan, K. S., Sastri, A. S. and Marcinkowski, M. J. (1969). 'Nature of the Work-hardening Behaviour in Hadfields Manganese Steel', *Trans. A.I.M.E.*, **245**, 1569
- Raghavan, M. and Thomas, G. (1971). 'Structure and Mechanical Properties of Fe-Cr-C-Co Steels', *Met. Trans.*, **2**, 3433
- Rahl, F. J., Evanco, M. A., Fredericks, R. J. and Reimschuessel, A. C. (1972). 'Studies of the Morphology of Emulsion-grade Polytetrafluoroethylene', *J. Polymer Sci. Part A-2*, **10**, 1337
- Ramaswamy, U., Sumner, A. E. and West, D. R. F. (1968). 'Recrystallisation of a Commercial Austenitic (Fe-Cr-Ni-Nb) Steel', *JISI*, **206**, 85
- Ramaswamy, V., Swann, P. R. and West, D. R. F. (1972). 'Observations on Intermetallic Compound and Carbide Precipitation in Two Commercial Nickel-base Superalloys', *J. Less-Common Metals*, **27**, 17
- Rao, P., Livingston, J. D. and Koch, E. F. (1974). 'Crystallography of Aligned Copper-Aluminium Eutectoid', *Acta Met.*, **22**, 1513
- Rao, P. and Thomas, G. (1975). 'Interstitial Order and Embrittlement in Ta-C Alloys', *Acta Met.*, **23**, 309
- Räty, R., Lindroos, V., Saarinen, A., Forsten, N. J. and Miekko-Oja, H. M. (1966). 'The Preparation of Thin Foils for Electron Microscopy Using a Controlled Low Temperature Technique', *J. Sci. Instrum.*, **43**, 367
- Rau, R. C., Secco D'Arragona, F. and Ladd, R. L. (1970). 'Neutron Damage in Molybdenum Irradiated at High Temperatures', *Phil. Mag.*, **21**, 441
- Ravindran, C. and Chaturvedi, M. C. (1975). 'Effect of Aluminium Addition on the Precipitation Behaviour of a Co-Ni-Cr Base Superalloy Containing Nb', *Met. Trans.*, **6A**, 213
- Raymond, E. L. (1967). 'Effect of Grain Boundary Denudation of Gamma Prime on Notch-rupture Ductility of Inconel Nickel-Chromium Alloys X-750 and 718', *Trans. A.I.M.E.*, **239**, 1415
- Reid, C. N. and Gilbert, A. (1965). 'Dislocation Structure in Chromium, Chromium-Rhenium, and Chromium-Iron Alloys', *J. Less-Common Metals*, **10**, 77.
- Reid, C. N., Gilbert, A. and Hahn, G. T. (1967). 'Dislocation and Deformation Modes in Chromium Single Crystals', *Trans. A.I.M.E.*, **239**, 467
- Remaut, G., Lagasse, A. and Amelinckx, S. (1964). 'The Electron Microscopic Observation of Mechanical Twins in Indium', *Phys. Stat. Sol.*, **6**, 723
- Reneker, D. H. (1965). 'Localised Deformation of Lamellar Polyethylene Crystals', *J. Polymer Sci., Part A-3*, 1069
- Rennhack, E. H. (1974). 'Influence of Machining Temperature on the Surface Damage, Residual Stress and Texture of Hot-pressed Beryllium', *Met. Trans.*, **5**, 1095
- Rice, L., Hinesley, C. P. and Conrad, H. (1971). 'Techniques for Optical and Electron Microscopy of Titanium', *Metallography*, **4**, 257
- Rice, L. A. and Orava, R. N. (1966). 'The Preparation of Titanium for Transmission Electron Microscopy', *Trans. A.I.M.E.*, **236**, 1502
- Richardson, G. J., Sellars, C. M. and Tegart, W. J. McG. (1966). 'Recrystallisation During Creep of Nickel', *Acta Met.*, **14**, 1225
- de Ridder, R. and Amelinckx, S. (1971). 'The Structure of Defect Manganese Silicides', *Mat. Res. Bull.*, **6**, 1223
- Rider, J. G. and Foxon, C. T. B. (1966). 'An Experimental Determination of Electrical Resistivity of Dislocations in Aluminium', *Phil. Mag.*, **13**, 289
- Riley, A. (1974). 'The Observation of Defect and Magnetic Domain Structures in Cobalt-Rare-earth Intermetallic Compounds by Electron Microscopy', *J. Less-Common Metals*, **35**, 305
- Rinnovatore, J. V. and Brown, N. (1967). 'Observations of Substructures in Explosively Deformed and Annealed Beta Brass', *Trans. A.I.M.E.*, **239**, 225
- Roberge, R. and Leak, G. M. (1973). 'A Study of Iron in Gold-Iron Alloys', *Phys. Stat. Sol. (a)*, **19**, 695
- Roberts, M. J. (1970). 'Effect of Transformation Substructure on the Strength and Toughness of Fe-Mn Alloys', *Met. Trans.*, **1**, 3287
- Roberts, W. N. (1964). 'Deformation Twinning in Hadfield Steel', *Trans. A.I.M.E.*, **230**, 372
- Roberts, W. N. (1969). 'Persistent Slip Bands in Fatigued Copper', *Phil. Mag.*, **20**, 675
- Robertson, R. E. (1969). 'Formation of Kink Bands in Oriented Polymers', *J. Polymer Sci., Part A-2*, **7**, 1315
- Robinson, D. L. and Hunter, M. S. (1972). 'Interrelation of T.E.M. Microstructure, Com-

- position, Tensile Properties and Corrosion Resistance of Al–Cu–Mg–Mn Alloys', *Met. Trans.*, **3**, 1147
- Rosenberg, H. W. and Nix, W. D. (1970). 'Observation of Coplanar Dislocations in Cross-slip in Ti–15.5at. %Al', *Met. Trans.*, **1**, 2962
- Rossolimo, A. N. and Turnbull, D. (1973). 'Kinetics and Morphology of Precipitation AuPb₃ from Pb(Au) Solid Solution', *Acta Met.*, **21**, 21
- Rowcliffe, A. F. (1966). 'Improvements to Techniques for Preparing Thin Foils for Electron Microscopy', *JIM*, **94**, 263
- Rowcliffe, A. F. and Nicholson, R. B. (1972). 'Quenching Defects and Precipitation in a Phosphorus-containing Austenitic Stainless Steel', *Acta Met.*, **20**, 143
- Rowlands, P. C., Fearon, E. O. and Bevis, M. (1970). 'The Application of the Kossel Technique and Electron Microscopy to the Study of the Microstructure of F–32 %Ni Martensite Crystals', *J. Mat. Sci.*, **5**, 769
- Ruff, A. W. and Ives, L. K. (1973). 'On the Temperature Dependence of Stacking Fault Energy in Cubic and Hexagonal Silver–Tin Alloys', *Phys. Stat. Sol. (a)*, **16**, 133
- Rusnock, J. A. and Hansen, D. (1965). 'Application of Transmission Electron Microscopy to Polymer Thin Sections. Part I: Observations on Nylon 66, Bulk and Filament Forms', *J. Polymer Sci.*, Part A-3, 647
- Russel, G. J., Martin, K. J. and Bowen, D. H. (1970). 'The Production of Lithium Oxide by Electron Irradiation of Lithium Fluoride', *J. Mat. Sci.*, **5**, 172
- Ryan, N. E. and Johnstone, T. M. (1970). 'The Influence of a Carbide Dispersion on the Recrystallisation Behaviour of Chromium', *J. Less-Common Metals*, **20**, 7
- Ryum, N. (1969). 'Precipitation and Recrystallisation in an Al–0.5wt. %Zr Alloy', *Acta Met.*, **17**, 269
- Rybníkar, F. and Geil, P. H. (1972). 'Growth Stages in Epitaxial Crystallisation of Poly(γ -benzyl-L-glutamate)', *J. Polymer Sci.* Part A-2, **10**, 961
- Saburi, T., Kanai, E. and Nenno, S. (1974). 'Domain Structure in Ni₄Mo Alloy', *J. Less-Common Metals*, **37**, 59
- Saburi, T. and Nenno, S. (1967). 'Anti-phase Domains and Dislocation Configurations in the Fe–13at. %Si Alloy', *Phil. Mag.*, **15**, 813
- Saburi, T. and Wayman, C. M. (1965). 'Massive and Martensitic Transformations in Beta Cu–Ga Alloys', *Trans. A.I.M.E.*, **233**, 1373
- Sahoo, M. and Lund, J. A. (1973). 'Substructure and Dispersion Hardening in Aged, Cold Worked and Annealed Al–4wt. %Cu Alloy', *Met. Trans.*, **4**, 39
- Saito, M. H. and Tsuzuku, T. (1973). 'The Influence of Impurity-doping on Temperature Dependence of Dislocation – Ribbon Width in Graphite', *Carbon*, **11**, 469
- Sakai, M. and Mikkola, D. E. (1971). 'The Growth of Antiphase Domains in Cu₃Au as Studied by Transmission Electron Microscopy', *Met. Trans.*, **2**, 1635
- Sakaoku, K. and Peterlin, A. (1971). 'Electron Microscopy of Drawn Polypropylene', *J. Polymer Sci.*, Part A-2, **9**, 895
- Salmon Cox, P. H., Reisdorf, B. G. and Bellisier, G. E. (1967). 'The Origin and Significance of Banding in 18Ni (250) Maraging Steel', *Trans. A.I.M.E.*, **239**, 1809
- Sanderson, M. D. and Scully, J. C. (1970). 'Protective Oxide Formation on Cu–7.5Al–2Si Alloy', *Met. Trans.*, **1**, 1273
- Sandrock, G. D., Perkins, A. J. and Hehemann, R. F. (1971). 'The Premartensitic Instability in Near-equiatomic TiNi', *Met. Trans.*, **2**, 2769
- Sargent, G. A., Delaey, L. and Massalski, J. B. (1968). 'Formation of "Feathery" Structures During Massive Transformation in Cu–Ga Alloys', *Acta Met.*, **16**, 723
- Sass, S. L. (1969). 'Preparation of Lithium for Transmission Electron Microscopy', *Appl. Phys. Letters*, **14**, 365
- Satou, M., Watanabe, Y. and Hayashi, H. (1972). 'Morphological Study of Crystals Formed in Films Obtained by Evaporation and Deposition of Polyethylene', *J. Polymer Sci.*, Part A-2, **10**, 835
- Sauthoff, G. (1973). 'Growth Kinetics and Size Distribution of Ordered Domains in Cu₃Au', *Acta Met.*, **21**, 273
- Scarlin, R. B., Hollox, G. E. and Edington, J. W. (1971). 'The Distinction Between Ion Damage and the Early Stages of Carbide Precipitation in Nickel Alloys', *J. Mat. Sci.*, **6**, 1322
- Schaumburg, H. (1972). 'Geschwindigkeiten von Schrauben und 60° Versetzungen in Germanium', *Phil. Mag.*, **25**, 1429
- Schlump, W., Freyhardt, H. and Nembach, E. (1972). 'Dislocation Arrangement and Flux Pinning in Deformed Niobium Single Crystals', *Acta Met.*, **20**, 257
- Schmidt, P. H., Spencer, E. G. and Walters, E. M. (1970). 'Ion Milling of Magnetic Oxide Platelets for the Removal of Surface and Near-surface Imperfections and Defects', *J.A.P.*, **41**, 4740
- Schober, T. and Sorajíc, V. (1973). 'A New Method for Electropolishing Niobium for Transmission Electron Microscopy', *Metallography*, **6**, 183
- Schoone, R. D. and Fischione, E. A. (1966). 'Automatic Unit for Thinning Transmission Electron Micrograph Specimens of Metals', *Rev. Sci. Inst.*, **37**, 1351
- Schulson, E. M. and Teghtsoonian, E. (1969). 'The

- Plasticity of β' -AuZn Single Crystals', *Trans. A.I.M.E.*, **245**, 1527
- Schultz, J. M. and Shore, H. T. (1968). 'Morphological Study of the Ageing of a Zn-1 %Cu Alloy', *Trans. A.I.M.E.*, **242**, 1381
- Schwartz, L. H., Mahajan, S. and Plewes, J. T. (1974). 'Spinodal Decomposition in a Cu-9wt. % Ni-6wt. %Sn Alloy', *Acta Met.*, **22**, 601
- Segall, R. L. and Clarebrough, L. M. (1964). 'Influence of Oxidising and Reducing Treatments on Vacancy Clustering in Gold', *Phil. Mag.*, **9**, 865
- Seimiya, T., Yamamoto, H. and Sasaki, T. (1970). 'Effect of Bending and Stretching of Polyethylene Strips on the Absorption of Surface Active Substances', *J. Polymer Sci. Part A-2*, **8**, 595
- Shapiro, S. and Krauss, G. (1967). 'The Crystallography of the Reverse Martensitic Transformation in an Iron-Nickel Alloy', *Trans. A.I.M.E.*, **239**, 1408
- Shapiro, S., Tyler, D. E. and Lanam, R. (1974). 'Phenomenology of Precipitation in Copper-20 %Nickel-20 %Manganese', *Met. Trans.*, **5**, 2457
- Shappirio, J. R., Eckart, D. W. and Cook, C. F. Jr. (1970). 'Chemical and Structural Characterisation of Amorphous Semiconducting Materials in the System Ga-As-Te-Ge', *J. Non-Cryst. Solids*, **2**, 217
- Shaw, R. R. and Uhlmann, D. R. (1969). 'Effect of Phase Separation on the Properties of Simple Glasses', *J. Non-Cryst. Solids*, **1**, 474
- Shen, Y. S. and Griffiths, L. B. (1970). 'The Development of a Pseudo-eutectic Nickel-based Composite Alloy', *Met. Trans.*, **1**, 2305
- Shimonura, Y. (1969). 'Interstitial Clusters Observed below Stage III Annealing in Electron Irradiated Pure Gold', *Phil. Mag.*, **19**, 773
- Siems, R., Delavignette, P. and Amelinckx, S. (1964). 'Stacking Faults, Ribbons and the Formation of Extended Jogs in Tin Disulphide', *Phil. Mag.*, **9**, 121
- Sikka, V. K., Michel, D. J. and Moteff, J. (1973). 'Twin-jet Thinning Techniques for Transmission Electron Microscopy Observation of Tantalum and Niobium', *J. Less-Common Metals*, **31**, 311
- Silcock, J. M. and Tunstall, W. J. (1964). 'Partial Dislocations Associated with NbC Precipitation in Austenitic Stainless Steels', *Phil. Mag.*, **10**, 361
- Silcock, J. M. and Williams, N. F. (1966). 'Precipitation During Ageing at 700°C of a Commercial Austenitic Steel Containing Titanium and Aluminium', *JISI*, **204**, 1100
- Singh, H. P. and Murr, L. E. (1972a). 'Nucleation and Growth Characteristics of Palladium and Indium Thin Films', *Met. Trans.*, **3**, 983
- Singh, H. P. and Murr, L. E. (1972b). 'Electron Microscopy of Nucleation and Growth of Indium and Tin Films' *Phil. Mag.*, **26**, 649
- Singh, R. N. and Tangri, K. (1970). 'Deformation Faulting in the Premacroyield Region of Polycrystalline Nickel', *Met. Trans.*, **1**, 3151
- Singh Deo, N. N. and Barrett, C. R. (1969). 'High-temperature Creep of Some Dilute Copper-Silicon Alloys', *Trans. A.I.M.E.*, **245**, 2467
- Singhal, L. K. and Martin, J. W. (1967a). 'Precipitation Processes in an Austenitic Stainless Steel Containing Titanium', *JISI*, **205**, 947
- Singhal, L. K. and Martin, J. W. (1967b). 'The Growth of $M_{23}C_6$ Carbide on Incoherent Twin Boundaries in Austenite', *Acta Met.*, **15**, 1603
- Singhal, L. K. and Martin, J. W. (1968). 'The Growth of $M_{23}C_6$ Carbide on Grain Boundaries in an Austenitic Stainless Steel', *Trans. A.I.M.E.*, **242**, 814
- Slakhorst, J. W. H. G. (1975). 'The Development of Recrystallisation Textures in F.C.C. Metals with a Low Stacking Fault Energy', *Acta Met.*, **23**, 301
- Slattery, G. A. (1968). 'The Effect of Cooling Rate on the β - α -Transformation in the Zirconium/2at. %Chromium/0.16at. %Iron Alloy', *J. Less-Common Metals*, **16**, 91
- Smidt, F. A., Jr. and Mastel, B. (1969). 'Some Observations of Dislocation Channelling in Irradiated Iron', *Phil. Mag.*, **20**, 651
- Snow, D. B. and Breedis, J. F. (1974). 'Deformation of Single-crystal Ruthenium', *Acta Met.*, **22**, 419
- Sole, M. J. and van der Walt, C. M. (1968). 'Oxidation and Deformation Studies of Uranium Nitride by Electron Microscopy', *Acta Met.*, **16**, 501
- Sole, M. J., van der Walt, C. M. and Truzenberger, M. (1968). 'Electron Microscopy Studies of Uranium Sulphide Single Crystals', *Acta Met.*, **16**, 667
- Speich, G. R. and Warlimont, H. (1968). 'Yield Strength and Transformation Substructure of Low-carbon Martensite', *JISI*, **206**, 385
- Spitzig, W. A. and Mitchell, J. E. (1966). 'Dislocation Arrangements in Tantalum Single Crystals Deformed in Tension at 373K', *Acta Met.*, **14**, 1311
- Spruiell, J. E., Scott, J. A., Ary, C. S. and Hardin, R. L. (1973). 'Microstructural Stability of Thermal-Mechanically Pretreated Type 316 Austenitic Stainless Steel', *Met. Trans.*, **3**, 1533
- Spyridelis, J. (1971). 'Dislocation Loops and Stacking Faults in Zinc', *Mat. Res. Bull.*, **6**, 1345
- Spyridelis, J., Delavignette, P. and Amelinckx, S. (1967a). 'Non-Stoichiometry and Interfacial Distributions in Tungsten Trioxide', *Mat. Res. Bull.*, **2**, 615
- Spyridelis, J., Delavignette, P. and Amelinckx, S. (1967b). 'Direct Observation of the Superlattices

- of Ta₂O₅ and Nb₂O₅ in the Electron Microscope', *Mat. Res. Bull.*, **2**, 113
- Srinivasan, G. R. and Wayman, C. M. (1968). 'Transmission Electron Microscopy Study of the Bainite Transformation on Iron–Chromium Carbon Steels', *Acta Met.*, **16**, 609
- Srinivasan, G. R., Tweer, I., Macedo, P. B. and Sarkar, A. (1971). 'Phase Separation in SiO₂–B₂O₃–Na₂O System', *J. Non-Cryst. Solids*, **6**, 221
- Stapley, A. J. and Beevers, C. J. (1969). 'Some Electron Microscope Observations of Alumina Whisker/Nickel Composites', *J. Mat. Sci.*, **4**, 65
- Starke, E. A. Jr., Gerold, V. and Guy, A. G. (1965). 'An Investigation of the K-Effect in Nickel–Aluminium Alloys', *Acta Met.*, **13**, 957
- Stellman, J. M. and Woodward, A. E. (1971). 'Chain Folding in Poly-*trans*-1, 4-butadiene Crystals Grown from Various Solvents', *J. Polymer Sci. Part A-2*, **9**, 59
- Stephens, J. R. (1968). 'Dislocation Structures in Slightly Strained Tungsten, Tungsten–Rhenium and Tungsten–Tantalum Alloys', *Trans. A.I.M.E.*, **242**, 634
- Stephens, J. R. (1970). 'Dislocation Structures in Single-crystal Tungsten and Tungsten Alloys', *Met. Trans.*, **1**, 1293
- Stevens, G. T. (1971). 'Electron Microscopy and Diffraction of CoPt', *J. Australian Inst. Metals*, **16**, 73
- Stevens, R. (1971a). 'Temperature Dependence of Fracture Effects in Self-bonded SiC', *J. Mat. Sci.*, **6**, 324
- Stevens, R. (1971b). 'Fracture Behaviour and Electron Microscopy of a Fine Grained Graphite', *Carbon*, **9**, 573
- Stevens, R. (1972). 'Twin Morphology in Silicon Carbide Whiskers', *J. Mat. Sci.*, **7**, 723
- Stevenson, R. and Vander Sande, J. B. (1974). 'The Cyclic Deformation of Magnesium Single Crystals', *Acta Met.*, **22**, 1079
- Stewart, I. M., Brough, I. and Green, L. (1967). 'The Electron Microscope and X-ray Diffraction Examination of a Lithium Zinc Silicate Glass-ceramic', *J. Mat. Sci.*, **2**, 63
- Stickler, R. and Booker, G. R. (1963). 'Surface Damage on Abraded Silicon Specimens', *Phil. Mag.*, **8**, 859
- Stickler, R. and Engle, R. J. (1963). 'Microjet Method for Preparation of Wire Samples for Transmission Electron Microscopy', *J. Sci. Instrum.*, **40**, 518
- St. John Manley, R. (1971). 'Molecular Morphology of Cellulose', *J. Polymer Sci. Part A-2*, **9**, 1025
- Stobbs, W. M. (1969). 'A Modification to the Jet Electropolishing Specimen Preparation Technique for Electron Microscopy', *J. Phys. E: Sci. Instrum.*, **2**, 202
- Stokes, R. J. (1966). 'Thermal–Mechanical History and the Strength of Magnesium Oxide Single Crystals. Part II: Etch Pit and Electron Transmission Studies', *J. Am. Ceram. Soc.*, **49**, 39
- Stubbington, C. A. and Forsyth, P. J. E. (1966). 'Some Observations on Microstructural Damage Produced by Fatigue of an Al–7.5%Zn–2.5% Mg Alloy at Temperatures between Room Temperature and 250°C', *Acta Met.*, **14**, 5
- Swann, P. R. (1966). 'Precipitation at Superlattice Domain Boundaries with Particular Reference to a Copper–Aluminium–Nickel Alloy', *Phil. Mag.*, **14**, 461
- Swann, P. R., Duff, W. R. and Fisher, R. M. (1972). 'The Electron Metallography of Ordering Reactions in Fe–Al Alloys', *Met. Trans.*, **3**, 409
- Swann, P. R. and Warlimont, H. (1963). 'The Electron-metallography and Crystallography of Copper–Aluminium Martensites', *Acta Met.*, **11**, 511
- Swann, P. R., Weissmann, D. and Wriedt, D. F. (1964). 'Aluminium–Oxygen Clusters in Internally Oxidised Silver–Aluminium Alloys', *Trans. A.I.M.E.*, **230**, 1306
- Sukhareva, L. A., Kovrizhnykh, Yu. P. and Zubov, P. J. (1969). 'The Formation of Supermolecular Structures in Polymerisation of Unsaturated Polyesters', *Polymer Sci. U.S.S.R.*, **11**, 2147
- Szilva, W. A., Murr, L. E. and Sattler, M. L. (1974). 'A Technique for Selected Area Observations in Silicon Wafers by Transmission Electron Microscopy', *J. Mat. Sci.*, **9**, 859
- Takano, S. and Suzuki, T. (1974). 'An Electron-optical Study of β -Hydride and Hydrogen Embrittlement of Vanadium', *Acta Met.*, **22**, 265
- Takeuchi, S., Furabayashi, E. and Taoka, T. (1967). 'Orientation Dependence of Yield Stress in 4.4% Silicon Iron Single Crystals', *Acta Met.*, **15**, 1179
- Takeuchi, S. and Kuramoto, E. (1973). 'Temperature and Orientation Dependence of the Yield Stress in Ni₃Ga Single Crystals', *Acta Met.*, **21**, 415
- Tangri, K. and Chaturvedi, M. (1969). 'Effect of 0.5wt.%Cu Addition on the Quench-ageing Transformations in Zr–2.5wt.%Nb (Cb) Alloy', *Trans. A.I.M.E.*, **245**, 99
- Tanner, L. E. (1966). 'Diffraction Contrast from Elastic Shear Strains Due to Coherent Phases', *Phil. Mag.*, **14**, 111
- Tanner, L. E., Clapp, P. C. and Toth, R. S. (1968). 'Short-range Order in Au–Mn and Au–Cr Alloys', *Mat. Res. Bull.*, **3**, 855
- Taplin, D. M. R. and Barker, L. J. (1966). 'A Study of the Mechanism of Intergranular Creep Cavitation by Shadowgraphic Electron Microscopy', *Acta Met.*, **14**, 1527
- Taylor, G. and Christian, J. W. (1967). 'Experiments on the Deformation of Niobium Single Crystals. Part II: Electron Microscope Study of Dislo-

- cation Structures', *Phil. Mag.*, **15**, 893
- van Tendeloo, G. and Amelinckx, S. (1973). 'The Domain Structure of the δ -phase Alloy NiMo', *Mat. Res. Bull.*, **8**, 721
- van Tendeloo, G., Delavignette, P., Gevers, R. and Amelinckx, S. (1973). 'A Study of Dissociated Antiphase Boundaries in Ni₃Mo', *Phys. Stat. Sol. (a)*, **18**, 85
- Thomas, C. B., Fray, A. F. and Basnell, J. (1972). 'The Switching Behaviour of Thin Films of Chalcogenide Glass', *Phil. Mag.*, **26**, 617
- Thomas, S. R. and Krauss, G. (1967). 'Cyclic Martensitic Transformation and the Structure of a Commercial 18Cr-8Ni Stainless Steel', *Trans. A.I.M.E.*, **239**, 1136
- Thompson, A. W. (1974). 'Hydrogen Compatibility of Dispersion-Strengthened Alloys', *Met. Trans.*, **5**, 1855
- Thompson, E. R. and Lemkey, F. D. (1970). 'Unidirectional Solidification of Co-Cr-C Monovariant Eutectic Alloys', *Met. Trans.*, **1**, 2799
- Thompson, S. J. and Flewitt, P. E. J. (1970). 'The Preparation of Small Niobium-25% Zirconium Alloy Wires for Electron Microscopy', *Metallography*, **3**, 477
- Thornton, P. H., Davies, R. G. and Johnston, T. L. (1970). 'The Temperature Dependence of the Flow Stress of the γ -phase Based Upon Ni₃Al', *Met. Trans.*, **1**, 207
- Thornton, P. H. and Govila, R. K. (1973). 'Presence of Coherent Precipitate in VC_{0.76} Monocrystals', *J. Less-Common Metals*, **30**, 343
- Tilley, R. J. D. (1970). 'The Formation of Shear Structures in Sub-Stoichiometric Tungsten Trioxide', *Mat. Res. Bull.*, **5**, 813
- Tisone, T. C. (1973). 'The Concentration and Temperature Dependence of the Stacking Fault Energy in F.C.C. Co-Fe Alloys', *Acta Met.*, **21**, 229
- Tisone, T. C., Chin, G. Y. and Wonsiewicz, B. C. (1970). 'Precipitation in Rolled Phosphor Bronze', *Met. Trans.*, **1**, 2010
- Toda, T. and Maddin, R. (1969). 'The Mechanical Properties of Splat-cooled Aluminium-base Gold Alloys', *Trans. A.I.M.E.*, **245**, 1045
- Tomlinson, H. W. (1958). 'An Electro-polishing Technique for the Preparation of Metal Specimens for Transmission Electron Microscopy', *Phil. Mag.*, **3**, 867
- Tomsett, D. J. and Bevis, M. (1969). 'The Formation of Stacking Faults in {1012} Twins in Zinc as a Result of Slip Dislocation Deformation Twin Interactions', *Phil. Mag.*, **19**, 533
- Toth, L. E., Cass, T. R., Ravitz, S. F. and Washburn, J. (1964). 'Determination of the Predominant Type of Stacking Fault in Cobalt by Nuclear Magnetic Resonance and Electron Microscopy', *Phil. Mag.*, **9**, 607
- Tousek, J. (1970). 'The Preparation of Platinum and Palladium Foils by a Electrolytic Polishing Method', *Prak. Metallog.*, **7**, 202
- Trenzinger, K., Jung, P. and Schulling, W. (1974). 'A Modulated Structure in the Tantalum-Nitrogen System', *Acta Met.*, **22**, 937
- Tressler, R. E. and Stubican, V. S. (1967). 'Preparation of Thin Films of Sulphospinel', *Mat. Res. Bull.*, **2**, 1119
- Tsui, R. T. C. (1967). 'Internal Friction and Transmission Electron Microscopy Studies of Magnesium. Part II: Electron Microscopy', *Acta Met.*, **15**, 1723
- Tsune-kawa, Y. and Weissmann, S. (1975). 'Dislocation Generation Associated with Crack Growth of Silicon Crystals Containing Precipitate Defect Structure', *Mater. Sci. Eng.*, **17**, 51
- Turnbull, J. A. and Stagg, M. S. (1966). 'Isothermal Annealing Studies on Vacancy and Interstitial Loops in Single Crystal Graphite', *Phil. Mag.*, **14**, 1049
- Uchida, T., Soen, T., Inoue, T. and Kawai, H. (1972). 'Domain Structure and Bulk Properties of Solvent-cast Films of A-B-A Block Copolymers of Styrene-Isoprene-Styrene', *J. Polymer Sci. Part A-2*, **10**, 101
- Urakami, A., Meshii, M. and Fine, M. E. (1970). 'Electron Microscopic Investigation of Prismatic Slip in Mg-10.5at.%Li Single Crystals', *Acta Met.*, **18**, 87
- Urban, K. and Seeger, A. (1974). 'Radiation-induced Diffusion of Point Defects During Low-temperature Electron Irradiation', *Phil. Mag.*, **30**, 1395
- Vadimsky, R. G., Keith, H. D. and Padden, F. J., Jr. (1969). 'Electron Microscopic Study of Deformation in Polyethylene', *J. Polymer Sci. Part A-2*, **7**, 1367
- Vagnard, G. and Washburn, J. (1968). 'Plastic Deformation of Cuprous Oxide', *J. Am. Ceram. Soc.*, **51**, 88
- Vahldiek, F. W. (1967a). 'Epitaxial Oxidation of Zirconium at Various Temperatures', *J. Less-Common Metals*, **12**, 19
- Vahldiek, F. W. (1967c). 'The Microstructure of Single-crystal Titanium Carbide', *J. Less-Common Metals*, **12**, 429
- Vahldiek, F. W. (1967d). 'Translucent ZrO₂ Prepared at High Pressures', *J. Less-Common Metals*, **13**, 530
- Vahldiek, F. W. (1968a). 'High-pressure Electrical Resistance Compressive Strength, and Non-stoichiometry of Titanium Dioxide', *J. Less-Common Metals*, **14**, 133
- Vahldiek, F. W. (1968b). 'Growth and Microstructure of Molybdenum Oxide Crystals', *J. Less-Common Metals*, **16**, 351

- Vahldiek, F. W. (1969). 'Hafnium. Part I: Microstructure', *J. Less-Common Metals*, **19**, 83
- Vahldiek, F. W. and Pence, R. E. (1967). 'Oxidation of Molybdenum Particles by Electron Microscopy at Various Temperatures', *J. Less-Common Metals*, **13**, 448
- Vandervoort, R. R. (1970). 'The Creep Behaviour of W-5Re', *Met. Trans.*, **1**, 857
- Vandervoort, R. R. and Barmore, W. L. (1969). 'High-temperature Plastic Deformation of Polycrystalline Rhenium', *Trans. A.I.M.E.*, **245**, 825
- Varschavsky, A., Pérez, M. I. and Löbel, T. (1975). 'An Electron Microscopic and Diffraction Study of Cu-9wt. %Al Alloy', *Met. Trans.*, **6A**, 577
- Venables, J. D. and Lye, R. G. (1969). 'Radiation Damage of Ordered V_6C_5 by Electron Microscope Beam Bombardment', *Phil. Mag.* **19**, 565
- Vesely, D. (1973). 'Dislocation Structure in Molybdenum Single Crystals after Deformation at 293 and 400K', *Phil. Mag.*, **27**, 607
- Vitek, J. M., Vander Sande, J. B. and Grant, N. J. (1975). 'Crystallisation of an Amorphous Cu-Zr Alloy', *Acta Met.*, **23**, 165
- Votava, E. (1961-62). 'The Phase Transformation in Thin Cobalt Films', *JIM*, **90**, 129
- Votava, E. (1962). 'Polygonisation and Stacking Faults in Molybdenum-Rhenium Alloys', *Acta Met.*, **10**, 745
- Wowles, M., Billingham, J. and Culpan, E. A. (1973). 'Correlation of Magnetic Permeability and Microstructure in Cupro-nickel Alloys', *Metal Sci. J.*, **7**, 77
- Wowles, M. D. J. and West, D. R. F. (1973). 'Precipitation Hardening in Iron-Chromium-Niobium Alloys', *JISI*, **211**, 147
- Vyhnal, R. F. and Radcliffe, S. V. (1967). 'Effects of Pressure on the Structure of Iron-Carbon Martensites', *Acta Met.*, **15**, 1475
- Walter, J. L., Cline, H. E. and Koch, E. F. (1969). 'Interface Dislocations in Directionally Solidified NiAl-Cr Autectic', *Trans. A.I.M.E.*, **245**, 2073
- Walter, J. L. and Koch, E. F. (1962). 'Electron Microscope Study of the Structures of Cold-rolled and Annealed (100) [001] Crystals of High Purity Silicon-Iron', *Acta Met.*, **10**, 1059
- Walter, J. L. and Koch, E. F. (1965). 'The Effect of Silicon on the Substructure of High-Purity Iron-Silicon Crystals', *Trans. A.I.M.E.*, **233**, 1209
- Walters, G. P. and Fuller, W. C. (1963). 'Preparation of Beryllium Thin Films', *Trans. A.I.M.E.*, **227**, 1462
- Wanagel, J., Sass, S. L. and Batterman, B. W. (1974). 'Observations on the Microstructure and Orientation Relations in the Vanadium-Hydrogen System', *Met. Trans.*, **5**, 105
- Warlimont-Meier, B., Beardmore, P. and Hull, D. (1967). 'Dislocation Densities in Tungsten', *Acta Met.*, **15**, 1399
- Watanabe, M. and Wayman, C. M. (1971). 'The Morphology and Substructure of Highly Tetragonal Martensites in Fe-7%Al-C Steels', *Met. Trans.*, **2**, 2221
- Watson, J. D. and Brown, G. G. (1974). 'The Strength and Ductility of Precipitation-hardened Fe-Si-Ti Alloys', *Metal Sci.*, **8**, 9
- Weatherly, G. C. (1968). An Electron Microscope Investigation of the Lamellar Al-CuAl₂ Eutectic', *Metal Sci. J.*, **2**, 25
- Weiner, R. T. and Froes, F. H. (1970). 'Precipitation in an Austenitic Stainless Steel Containing 20% Germanium', *Micron*, **1**, 466
- Wessling, R. A., Oswald, J. H. and Harrison, I. R. (1973). 'Effect of Polymerisation Conditions on the Morphology of As-polymerised Poly(vinylidene Chloride)', *J. Polymer Sci. P.P.E.*, **11**, 875
- Westlake, D. G. (1967). 'Problems in the Preparation of Vanadium-Hydrogen Alloys for Transmission Electron Microscopy', *Trans. A.I.M.E.*, **239**, 1106
- Westlake, D. G. (1969). 'Mechanical Behaviour of Niobium (Columbium)-Hydrogen Alloys', *Trans. A.I.M.E.*, **245**, 1969
- Whapham, A. D. and Sheldon, B. E. (1965). 'Radiation Damage in Uranium Dioxide', *Phil. Mag.*, **12**, 1179
- Wheeler, G. A. and Price, C. W. (1967). 'A Metallographic Technique for Polishing and Etching Beryllium', *Trans. A.I.M.E.*, **239**, 1657
- Wicks, B. J. (1968). Ph.D. Thesis, University of Warwick
- Wicks, B. J. (1971). 'Direct Observations of the Internal Structure of Carbon Fibres', *J. Mat. Sci.*, **6**, 173
- van Wijngaarden, J. D. (1966). 'Elektronen Mikroskopisch Onderzoek van Plastics', App. Lab. EM Dsx-68-TI, P.I.T. Electron Optics, Philips Industries, Eindhoven, Holland
- van Wijngaarden, J. D. (1967). 'E. M. Onderzoek aan Thermoplasten met Behulp van de Coupettechniek', App. Lab. EM DSX-68-Rkunstst, P.I.T. Electron Optics, Philips Industries, Eindhoven, Holland
- Wilcox, B. A. and Gilbert, A. (1967). 'Substructural Strengthening of a Precipitation Hardened Molybdenum Alloy', *Acta Met.*, **15**, 601
- Wilcox, B. A. and Smith, G. C. (1964). 'The Portwin-LeChatelier Effect in Hydrogen Charged Nickel', *Acta Met.*, **12**, 371
- Wilkes, R. S., Desport, J. A. and Bradley, R. (1967). 'Transmission Electron Microscopy of Neutron-irradiated α -Al₂O₃ Single Crystals', *Proc. Brit. Ceramic Soc.*, **7**, 403
- Williams, D. B. and Edington, J. W. (1974).

- 'Microanalysis of Al-Li Alloys Containing Fine δ' - (Al_3Li) Precipitates', *Phil. Mag.*, **30**, 1147
- Williams, J., Carrier, G. B., Holland, H. J. and Farncomb, F. J. (1967). 'The Determination of the Crystalline Content of Glass-ceramics', *J. Mat. Sci.*, **2**, 513
- Williams, J. C., Hickman, B. S. and Leslie, D. H. (1971). 'The Effect of Ternary Additions on the Decomposition of Metastable Beta-Phase Titanium Alloys', *Met. Trans.*, **2**, 477
- Williams, J. C., Taggart, R. and Polonis, D. H. (1971a). 'An Electron Microscopy Study of Modes of Intermetallic Precipitation in Ti-Cu Alloys', *Met. Trans.*, **2**, 1139
- Wilson, F. G. and Owen, W. S. (1965). 'First Stage Tempering of Low-chromium Hypereutectoid Steels', *JISI*, **203**, 590
- Wirth, A. and Bickerstaffe, J. (1974). 'The Morphology and Substructure of Martensite in Maraging Steels', *Met. Trans.*, **5**, 799
- Witcomb, M. J., Echarri, A., Narlikar, A. V. and Dew-Hughes, D. (1968). 'Effect of Microstructure on Superconducting Properties of Mo-34at. % Re Alloy', *J. Mat. Sci.*, **3**, 191
- Witcomb, M. J. and Dew-Hughes, D. (1973). 'Superconductivity of Heat Treated Nb-65at. % Ti Alloy', *J. Mat. Sci.*, **8**, 1383
- Wlodek, S. T. (1964a). 'The Oxidation of Hastelloy Alloy X', *Trans. A.I.M.E.*, **230**, 177
- Wlodek, S. T. (1964b). 'The Oxidation of René 41 and Udimet 700', *Trans. A.I.M.E.*, **230**, 1078
- Woodilla, J. E. Jr. and Averbach, B. L. (1968). 'Modulated Structures in Au-Ni Alloys', *Acta Met.*, **16**, 255
- Woodilla, J. E., Jr. and Averbach, B. L. (1970). 'Moiré Patterns in Electron Transmission Through Au-Ni Alloys', *Met. Trans.*, **1**, 1325
- Worthington, P. (1973). 'Observation of Polytypes and Stacking Faults in Zinc Sulphide by Transmission Electron Microscopy', *J. Mat. Sci.*, **8**, 1194
- Wronski, A. and Fourdeux, A. (1964). 'Slip-induced Cleavage in polycrystalline Tungsten', *J. Less-Common Metals*, **6**, 413
- Wronski, A. and Fourdeux, A. (1964a). 'The Deformation of Polycrystalline Niobium at Room Temperature', *J. Less-Common Metals*, **7**, 205
- Wynne, B. E., Edington, J. W. and Rothwell, G. P. (1972). 'The Transformation on Annealing of the Metastable Electrodeposit, NiSn_x to its Equilibrium Phases', *Met. Trans.*, **3**, 301
- Yada, K. and Torigoe, K. (1973). 'Electron microscopic Evidence of Transformation-induced Lattice Defects in Grey Tin', *J. Mat. Sci.*, **8**, 297
- Yamamoto, N., Yagi, K. and Honjo, G. (1974). 'Electron Microscopic Observation of Ferroelectric and Antiphase Domains in Gd $(\text{MoO}_4)_3$ ', *Phil. Mag.*, **30**, 1161
- Yamane, T. and Ueda, J. (1966). 'Transmission Electron Microscope Structure of a Ti-9wt. % Ta Alloy Quenched from the β -region', *Acta Met.*, **14**, 438
- Yamashita, Y. (1965). 'Single Crystals of Poly (ethylene terephthalate)', *J. Polymer Sci. Part A*, **3**, 81
- Yamashita, Y. and Monobe, K. (1971). 'Single Crystals of Amylose V complexes. Part III: Crystals with 8_1 Helical Configuration', *J. Polymer Sci.*, **9**, 1471
- Youngblood, J. L. (1969). 'Preparation of Samples for Transmission Electron Microscopy by Illuminated Jet Polishing', *Trans. Quart. A.S.M.*, **62**, 1019
- Yue, A. S., Crossman, F. W., Vidoz, A. E. and Jacobson, M. I. (1968). 'Controlled Microstructures of Al-CuAl₂ Eutectic Composites and their Compressive Properties', *Trans. A.I.M.E.*, **242**, 2441
- Zarzycki, J. and Naudin, F. (1969). 'Spinodal Decomposition in the B_2O_3 -PbO-Al₂O₃ System', *J. Non-Crystalline Solids*, **1**, 215
- Zaspinsk, G. S., Zhegalova, N. N., Vasil'ev, B. V. and Tarakanov, O. G. (1969a). 'The Structure of Solutions and Condensed Structures of Cellulose Triacetate', *Polymer Sci. U.S.S.R.*, **11**, 2468
- Zaspinsk, G. S., Zhegalova, N. N., Vasil'ev, B. V., Naimark, N. I. and Tarakanov, O. G. (1969b). 'Structural Study of Triacetate Fibre', *Polymer Sci. U.S.S.R.*, **11**, 172
- Zielinski, R. E. and Sikka, V. K. (1973). 'Electropolishing of Iridium Foils for Transmission Electron Microscopy', *J. Less-Common Metals*, **31**, 393
- Zijlstra, S. R., Beijer, J. and Klostermann, J. A. (1974). 'An Electron-microscopical Investigation on the Martensitic Transformation in TiNi', *J. Mat. Sci.*, **9**, 145

INDEX

- Acetic anhydride, danger of, 24
- Analar grade of chemicals, 24
- Artifacts, 12
 - carbon contamination, 15
 - careless handling, 12
 - careless washing, 12
 - deformation twinning, 15
 - deposited epitaxial layers, 14
 - dislocation generated by bending, 15
 - dislocation rearrangement, 14
 - etching, 14
 - hydrogen contamination, 12
 - interstitial contamination, 12
 - ion damage, 12
 - oxidation, 14
 - oxide spots in diffraction patterns, 14
 - redeposition of second-phase particles, 14
 - split Kikuchi lines, 14
 - spontaneous martensite, 14
 - spontaneous phase transformation, 15
 - streaks in diffraction patterns from surface films, 14
 - surface films, 15
 - surface mottling, 14
 - surface nucleation of precipitates, 15
 - veining, 14
- Carbon contamination, 15
- Careless handling, 12
- Careless washing, 12
- Chemical concentrations, 24
- Chemical polishing, 8
 - disc technique, 8
 - non-conducting materials, 8
 - window technique, 8
- Chromic acid solutions, 24
- Clean surfaces, 4
- Cooling baths, 11
 - safety precautions, 12
 - temperatures, 11, 12
- Current density, 3
- Damage
 - grinding, 1
 - grinding in aluminium, 2
 - grinding in silicon, 2
 - grinding in steel, 2
 - removal, 1
 - spark machining in steel, 2
 - vibratory polishing, 2
- Deformation twinning, 15
- Deposited epitaxial layers, 14
- Disc techniques, 1
 - automatic detection of perforation, 5
 - calibration, 6
 - dish shape, 6
 - dish shape versus voltage, 6
 - electropolishing, 4
 - electropolishing single stage, 5
 - ion-beam thinning, 7
 - low electrical conductivity specimens, 5
 - p.t.f.e. specimen holder, 4
 - submerged jets, 5
 - two-stage processes, 6
- Dislocation, generated by bending, 15
- Dislocation rearrangement, 14
- Electrolyte contamination, 11
- Electropolishing
 - cell, 2
 - constant voltage supply, 10
 - d.c. battery supplies, 10
 - potentiostatically controlled, 10
 - power supplies, 10
 - rectified supply, 10
- Etching, 14
- Explosions, 29
- First-aid treatment, for hydrogen fluoride burns, 22
- General safety rules, 24
- Glasses, specialised techniques, 8
- Grinding, 1
- Hydrogen contamination, 12
- Hydrogen fluoride, 22
- Interstitial contamination, 12
- Ion-beam cleaning, 7
- Ion-beam damage, 14
- Ion-beam localisation, 7
- Ion-beam penetration versus angle of incidence, 7
- Ion-beam spark machine dishing, 7
- Ion-beam thinning rate, 7
- Ion-beam thinning rate versus angle of incidence, 7
- Ion-beam thinning surface roughening, 7
- Ion-beam ultrasonic dishing, 7
- Ion-beaming
 - porous ceramics, 8
 - repeated, 8
 - slivers of brittle materials, 7
- Lacquer, acid resisting, 2
- Mechanical polishing, 1
- Methyl alcohol, danger of, 24
- Nitric acid solutions, 24
- Osmium tetroxide, 10
- Oxidation, 14
- Oxide spots, in diffraction patterns, 14
- Perchloric acid
 - safety rules, 23
 - solutions, 23
- Perforation, window technique, 3
- Polymers
 - etching, 17
 - extraction, 17
 - ion-bombardment, 17
 - replication, 10
 - shadowing, 8
 - specialised techniques, 8
 - staining, 10
 - ultramicrotome, 9
- Polymers, selective stains, 10
 - bromine vapour, 10
 - chromic acid, 10
 - iodine vapour, 10
 - phosphotungstic acid, 10
- Potentiostat, 4
- Potentiostatic techniques, 4
- Potentiostatically controlled electropolishing, 4
- Purities, of chemicals, 24
- Redeposition, of second-phase particles, 14
- Replicas
 - astigmatism correction, 17
 - cellulose, 17
 - chemical etching, 16
 - contrast improvement, 16
 - electrolytic etching, 16
 - fracture chips, 16
 - gelatine, 16
 - high resolution, 15
 - holey, 17
 - oxide, 16
 - polymers, 17
 - removal from metal surface, 16
 - shadowing, 16
 - single-stage, 15
 - specific areas, 17
 - stripped, 17
 - stripping, 16

- two-stage, 16
- Safety, 22
 - cyanides, 22
 - explosions, 23
 - face guard, 22
 - first aid treatment for hydrogen fluoride burns, 22
 - hydrogen fluoride, 22
 - perchloric acid, 23
 - rubber gloves, 22
 - safe compositions of acid mixes, 23
 - specific gravity, 24
- Saturated calomel electrode, 4
- Slitting wheel, 1
- Spark machine, 1
- Specialised techniques, 8
 - glasses, 8
 - polymers, 8
- Specimens
 - cleaning, 2
 - contamination with dust, 2
 - contamination with talcum powder, 2
 - etching, 2
 - lacquer removal, 10
 - magnetic field, 10
 - mounting, 10
 - potential, 3
 - selection of specimen preparation technique, 10
 - storage, 10
 - thickness damaged by grinding, 2
 - washing, 10
- Split Kikuchi lines, 14
- Spontaneous martensite, 14
- Spontaneous phase transformation, 15
- Standard electrode, 4
- Streaks, in diffraction patterns from surface films, 14
- Surface films, 15
- Surface mottling, 14
- Surface nucleation of precipitates, 15
- Test specimens
 - high resolution, 19
 - partially graphitised carbon black, 19
 - point to point resolution tests, 19
 - single-crystal gold films, 19
- Thin sheet material, 1
- Veining, 14
- Window technique, 1, 2