

JAPANESE  
INDUSTRIAL  
STANDARD

Translated and Published by  
Japanese Standards Association

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**JIS G 0555** : 2003  
(JISF/JSA)

**Microscopic testing method for  
the non-metallic inclusions in steel**

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ICS 77.040.99

Reference number : JIS G 0555 : 2003 (E)

## Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF)/the Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently JIS G 0555 : 1998 is replaced with this Standard.

This revision has been made based on ISO 4967 : 1998 *Steel—Determination of content of nonmetallic inclusions—Micrographic method using standard diagrams* for the purposes of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 1956-12-15

Date of Revision: 2003-06-20

Date of Public Notice in Official Gazette: 2003-06-20

Investigated by: Japanese Industrial Standards Committee  
Standards Board  
Technical Committee on Iron and Steel

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JIS G 0555:2003, First English edition published in 2003-11

Translated and published by: Japanese Standards Association  
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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the original JIS is to be the final authority.

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Printed in Japan

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## Microscopic testing method for the non-metallic inclusions in steel

**Introduction** This Japanese Industrial Standard has been prepared based on the second edition of **ISO 4967 Steel—Determination of content of nonmetallic inclusions—Micrographic method using standard diagrams** published in 1998 without modifying the technical contents, but items not specified in **ISO 4967 : 1998** are supplemented.

Portions sidelined or underlined with dots are the matters not stated in the original International Standard.

**1 Scope** This Standard specifies a microscopic testing method for measuring non-metallic inclusions in steel products which are rolled or forged by a reduction ratio of at least 3 using standard diagrams.

**Information :** This method is widely used to assess the suitability of a steel for a given use. However, since it is difficult to achieve reproducible results owing to the influence of the test operator, even with a large number of specimens, precautions should be taken when using the method.

In this Standard, measurement of non-metallic inclusions by an image processing technique is shown in annex D for information.

In addition, microscopic testing method for measuring the type and quantity of non-metallic inclusions in steel (hereafter referred to as “inclusions”) with a microscope to judge the cleanliness, is given in annex 1.

**Information :** For certain types of steel (e.g., free cutting steels), the standardized diagrams described in this Standard may not be applicable.

**Remarks :** The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are **IDT** (identical), **MOD** (modified), and **NEQ** (not equivalent) according to **ISO/IEC Guide 21**.

**ISO 4967 : 1998** *Steel—Determination of content of nonmetallic inclusions—Micrographic method using standard diagrams* (MOD)

**2 Principle** The method consists of comparing the observed field to the chart diagrams defined in this Standard and separately taking into consideration each type of inclusion. In the case of image analysis, fields will be rated according to the relationships given in annex D.

The chart diagrams correspond to square fields of view, each with an area of 0.50 mm<sup>2</sup>, as obtained with a longitudinal plane-of-polish and as observed at 100×. According to the shape and distribution of the inclusions, the standard diagrams are divided into five main groups, bearing the reference A, B, C, D and DS. These five groups represent the most commonly observed inclusion types and morphologies:

- Group A (sulfide type): highly malleable, individual grey particles with a wide range of aspect ratios (length/width) and generally rounded ends;
- Group B (aluminate type): numerous non-deformable, angular, low aspect ratio (generally  $<3$ ), black or bluish particles (at least three) aligned in the deformation direction;
- Group C (silicate type): highly malleable, individual black or dark grey particles with a wide range of aspect ratios (generally  $\geq 3$ ) and generally sharp ends;
- Group D (globular oxide type): non-deformable, angular or circular, low aspect ratio (generally  $<3$ ), black or bluish, randomly distributed particles;
- Group DS (single globular type): circular, or nearly circular, single particle with a diameter  $\geq 13 \mu\text{m}$ .

Non-traditional inclusion types may also be rated based on their morphology compared to the above five types and a statement about their chemical nature. As an example, globular sulfides would be rated as a D type and a descriptive subscript (e.g.,  $D_{\text{sulf}}$ ) defined in the test report.  $D_{\text{cas}}$  would indicate globular calcium sulfides;  $D_{\text{RES}}$  would indicate globular rare earth sulfides;  $D_{\text{Dup}}$  would indicate globular duplex inclusions, such as calcium sulfide surrounding an aluminate.

Types of precipitate such as borides, carbides, carbonitrides or nitrides may also be rated based on their morphology compared to the above five types and a statement about their chemical nature as described in the previous subclause.

The diagrams on the chart are given, by inclusion group, in annex A. These chart diagrams carry an index number,  $i$ , from 0.5 to 3, the numbers increasing with the inclusion or stringer lengths (Groups A, B, C) or by the number (Group D) or by the diameter (Group DS), as defined in table 1, and by thickness, as defined in table 2. For example, the diagram A2 indicates that the shape of the inclusions observed under the microscope is in accordance with group A and that their distribution and quantity are in accordance with number 2.

**Table 1 Rating limits**

| Chart diagram index<br><i>i</i> | Inclusion group                    |                                    |                                    |                      |                                 |
|---------------------------------|------------------------------------|------------------------------------|------------------------------------|----------------------|---------------------------------|
|                                 | A<br>total length<br>$\mu\text{m}$ | B<br>total length<br>$\mu\text{m}$ | C<br>total length<br>$\mu\text{m}$ | D<br>count<br>number | DS<br>diameter<br>$\mu\text{m}$ |
| 0.5                             | $\geq 37$ and $< 127$              | $\geq 17$ and $< 77$               | $\geq 18$ and $< 76$               | $\geq 1$ and $< 4$   | $\geq 13$ and $< 19$            |
| 1                               | $\geq 127$ and $< 261$             | $\geq 77$ and $< 184$              | $\geq 76$ and $< 176$              | $\geq 4$ and $< 9$   | $\geq 19$ and $< 27$            |
| 1.5                             | $\geq 261$ and $< 436$             | $\geq 184$ and $< 342$             | $\geq 176$ and $< 320$             | $\geq 9$ and $< 16$  | $\geq 27$ and $< 38$            |
| 2                               | $\geq 436$ and $< 649$             | $\geq 342$ and $< 555$             | $\geq 320$ and $< 510$             | $\geq 16$ and $< 25$ | $\geq 38$ and $< 53$            |
| 2.5                             | $\geq 649$ and $< 898$             | $\geq 555$ and $< 822$             | $\geq 510$ and $< 746$             | $\geq 25$ and $< 36$ | $\geq 53$ and $< 76$            |
| 3                               | $\geq 898$ and $< 1\ 181$          | $\geq 822$ and $< 1\ 147$          | $\geq 746$ and $< 1\ 029$          | $\geq 36$ and $< 49$ | $\geq 76$ and $< 107$           |

- Remarks 1 The above length values for the A, B and C groups have been computed from the equations given in annex D and then rounded off to the nearest whole number.
- 2 An inclusion exceeding the range given in the table is rated in accordance with annex D.

**Table 2 Inclusion thickness parameters**

| Group | Finer series                   |                                | Thicker series                 |                                |
|-------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
|       | Minimum width<br>$\mu\text{m}$ | Maximum width<br>$\mu\text{m}$ | Minimum width<br>$\mu\text{m}$ | Maximum width<br>$\mu\text{m}$ |
| A     | 2                              | 4                              | 4                              | 12                             |
| B     | 2                              | 9                              | 9                              | 15                             |
| C     | 2                              | 5                              | 5                              | 12                             |
| D     | 3                              | 8                              | 8                              | 13                             |

- Remarks 1 For type D the maximum dimension is defined as the diameter.
- 2 Inclusions of at least the maximum width in the thicker series are independently recorded.

Remarks : Prior to the test, in order to distinguish characteristics of an inclusion being not common, the inclusion may be observed by not less than 100 magnifications.

**3 Sampling** The shape of the inclusion largely depends on the degree of reduction ratio of the steel; therefore, comparative measurements may only be carried out on prepared sections taken from samples with a similar ratio of deformation.

The polished surface of the specimen used to determine the content of inclusions shall be approximately  $200\text{ mm}^2$  ( $20\text{ mm} \times 10\text{ mm}$ ). It shall be parallel to rolled direction or forged axis of the product and shall be located halfway between the outer surface and the centre.

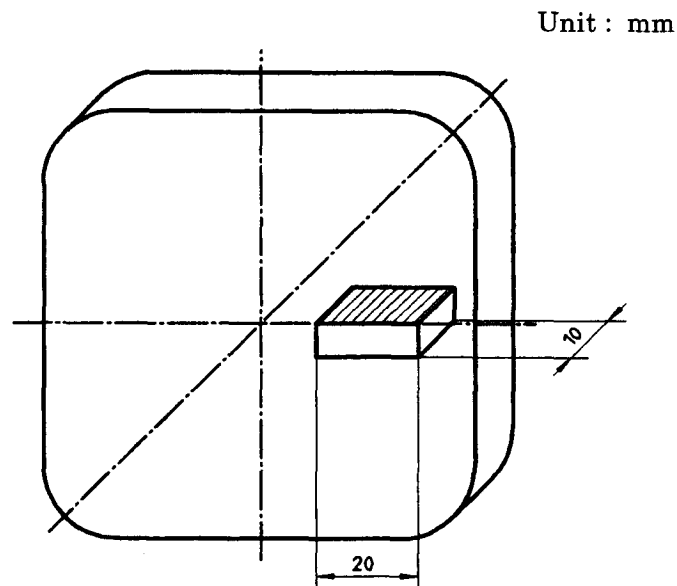
The sampling procedure shall be defined in the product standard or subject to agreement between the parties. The test surface, in the case of plates, shall be taken at approximately a quarter of the width.

In the absence of such specifications, the sampling procedure shall be as follows:

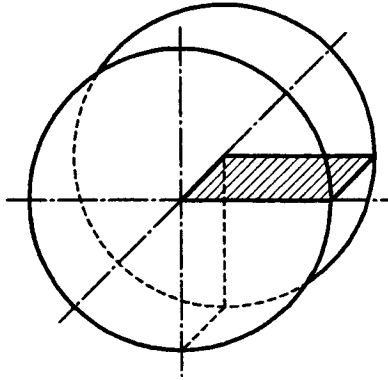
- bar or billet with diameters greater than 40 mm: the surface to be examined consists of a part of diametral section located halfway between the outer surface and the centre (see figure 1);
- bar or billet with a diameter greater than 25 mm and less than or equal to 40 mm: the surface to be examined consists of half the diametral section (from the centre to the edge of the sample) (see figure 2);
- bar with a diameter less than or equal to 25 mm: the surface to be examined consists of the full diametral section of length sufficient to obtain a surface of about 200 mm<sup>2</sup> (see figure 3);
- plates with a thickness less than or equal to 25 mm: the surface to be examined consists of the whole thickness, and located at the quarter point of the width (see figure 4);
- plates with a thickness greater than 25 mm and less than or equal to 50 mm: the surface to be examined consists of the thickness from the surface to the centre and is located at a quarter of the width (see figure 5);
- plates with a thickness greater than 50 mm: the surface to be examined consists of quarter the thickness and is located from halfway between the outer surface and the middle to the middle of the thickness and at the quarter of the width (see figure 6).

The number of samples to be taken is defined in the product standard or by special agreement.

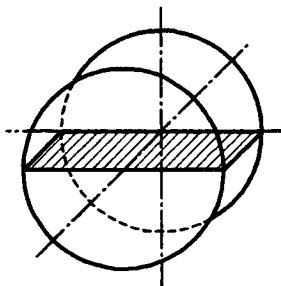
For any other product, the sampling procedures shall be subject to agreement between the parties.



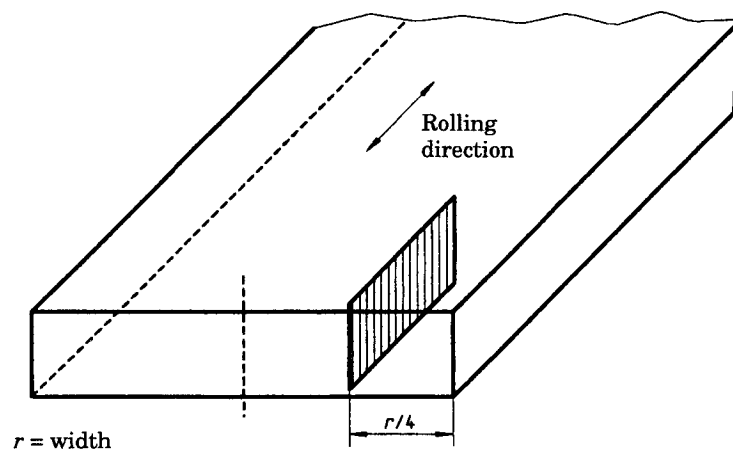
**Figure 1 Sample from bar or billet with a diameter or length of side > 40 mm**



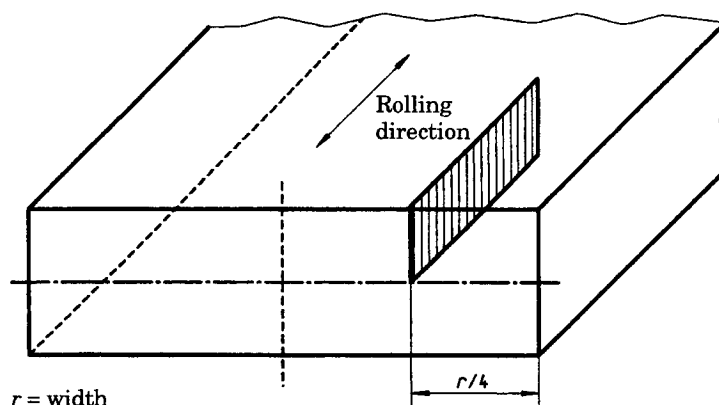
**Figure 2** Sample from bar or billet with a diameter or length of side  $> 25$  mm and  $\leq 40$  mm



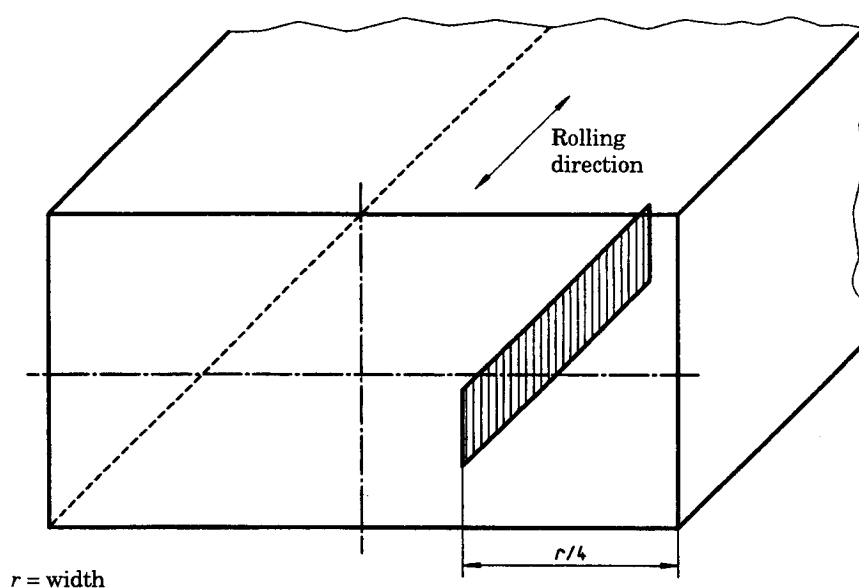
**Figure 3** Sample from bar with a diameter or length of side  $\leq 25$  mm



**Figure 4** Sample from plate with thickness  $\leq 25$  mm



**Figure 5 Sample from plate with thickness  $>25$  mm and  $\leq 50$  mm**



**Figure 6 Sample from plate with thickness  $>50$  mm**

**4 Preparation of test piece** The test piece shall be cut so as to obtain a surface for examination. In order to achieve a flat surface and to avoid rounding the edges of the specimen, the test piece may be held mechanically or may be mounted when polishing.

When polishing specimens, it is important to avoid any tearing out or deformation of the inclusions, or contamination of the polished surface, so that the surface is as clean as possible and the shape of the inclusions is not affected. These precautions are of particular importance when the inclusions are small. It is advisable to use diamond paste for polishing. In certain cases it may be necessary for the test piece to be heat treated before polishing in order to give it the maximum possible hardness.

## **5 Determination of the content of inclusions**

**5.1 Method of observation** Examination with microscope may be by one of two methods:

- by projection on to ground glass,
- by observation by means of an eyepiece.

The method of observation chosen shall be maintained throughout the test.

If the image is projected onto a ground glass or similar device, the magnification must be  $100 \times \pm 2 \times$  on the ground glass. Place a clear plastic overlay (figure 7) of a 71 mm square ( $0.50 \text{ mm}^2$  true area) over or behind the ground glass projection screen.

The image within the test square is compared to the chart diagrams (annex A).

If the inclusions are examined through the microscope eyepieces, insert a reticle with the test pattern shown in figure 7 in the microscope at the appropriate location so that the test grid area is  $0.50 \text{ mm}^2$  at the image plane.

Remarks : In special cases, a magnification greater than 100 may be used, provided that the same magnification is applied for the chart diagrams, and shall be recorded in the test report.

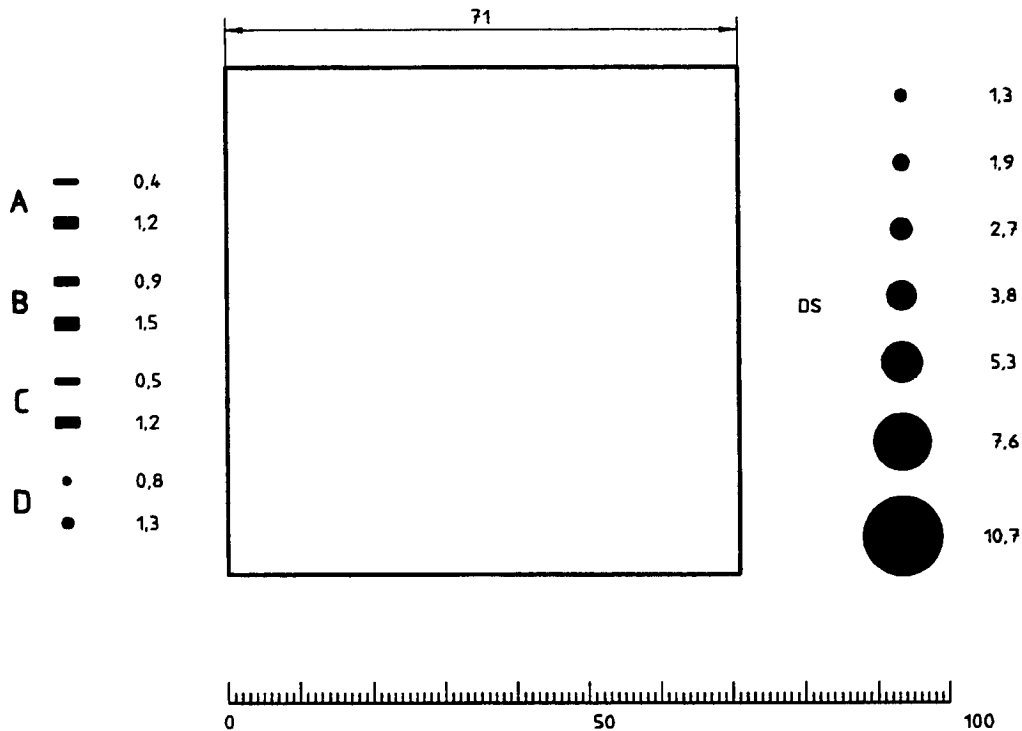


Figure 7 Test pattern for plastic grid overlays or reticles

**5.2 Actual examination** The two following methods are defined specified in 5.2.1 and 5.2.2.

**5.2.1 Method A** The entire polished surface is examined and, for each type of inclusion, a note is made of the reference number which lies to the side of the chart diagram which corresponds to the worst field examined, in the fine and thick series.

**5.2.2 Method B** The entire polished surface is examined and each field of the specimen is compared with the chart diagrams. The reference number of the field (indicated to the side of the chart diagrams) which best corresponds to the field examined for each type of inclusion is noted, in the fine and thick series.

In order to minimize the cost of examination, it may be agreed upon to make a partial examination of the specimen by studying a reduced number of fields, distributed in accordance with a fixed scheme. Both the number of fields examined and their distribution shall be arranged by prior agreement.

**5.2.3 General rules for methods A and B** Each field observed is compared with the chart diagrams. If a field of inclusions falls between two chart diagrams, it is rated following the lower reference number.

Individual inclusions or stringers that have a length greater than the field width (0.710 mm) or a width or diameter greater than the thick series maximum (see table 2) will be rated as oversized by length, width or diameter. The oversized dimensions of the inclusions or stringer shall be noted separately. However, these inclusions shall still be part of the overall rating of that field.

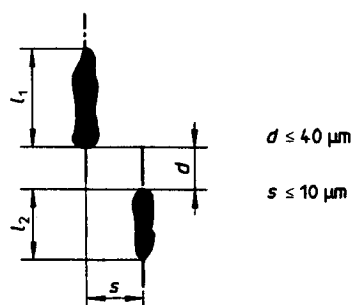
Reproducibility of measurements is improved if actual measurements (inclusion stringer lengths of A, B or C types, diameter of DS type) and counts (D types) are made. Use a plastic grid overlay or reticle, as shown in figure 7, the measurement limits in tables 1 and 2, and the morphological descriptions in section 2, as illustrated in the chart diagrams.

Non-traditional inclusion types are rated according to the chart group (A, B, C, D, DS) that best corresponds to their morphology. Compare the length, number, thickness or diameter of the inclusions to each group shown in annex A or determine their total length, number, thickness or diameter, and use tables 1 and 2 to assign the appropriate inclusion reference number and thickness class (fine, thick or oversized).

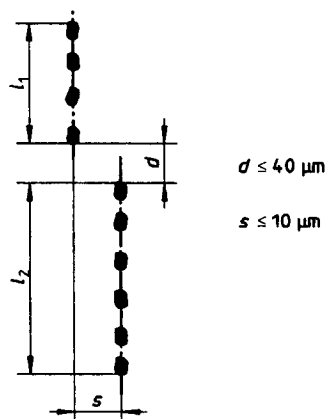
Then indicate the nature of the non-traditional inclusion with a subscript to the group type. Define the subscript in the test report.

For type A, B and C inclusions, two individual inclusions or stringers of lengths  $l_1$  and  $l_2$  and which are, or are not, in line are considered as one inclusion or stringer if the distance  $d$  is less than or equal to  $40\text{ }\mu\text{m}$  and if the distance  $s$ , the distance between centres of inclusions or stringers is less than or equal to  $10\text{ }\mu\text{m}$  (see figures 8 and 9).

In the case of a stringer with inclusions of different width, the width to be considered is the width of the biggest inclusion.



**Figure 8 Type A and C inclusions**



**Figure 9 Type B inclusions**

## 6 Expression of results

**6.1 General** Unless otherwise stated in the product standard, the results may be expressed in the following ways. The results are expressed with the reference numbers relating to each specimen and on their basis the arithmetic mean is assessed per cast for each type of inclusions and for each thickness series. This method is used in combination with the method described in 5.2.

**6.2 Method A** Indication of the reference number corresponding to the worst field for each type of inclusion and for each thickness series (see annex B). The reference symbol for the group of inclusions is followed by the reference number of the worst field, the presence of oversized thick inclusions being indicated by the letter e, the presence of other oversized inclusions being indicated by the letter s.

Examples : A2, B1e, C3, D1, B2s, DS0.5.

Any subscripts used to identify non-traditional inclusion types shall be defined.

**6.3 Method B** Indication of the total number of fields for a given index, per type of inclusion and per thickness series for a given number of fields observed ( $N$ ).

The full set of total numbers of fields for a given index relative to the various types of inclusions may be used in special methods for expressing results, such as total index,  $i_{tot}$ , or mean index,  $i_{moy}$ , subject to agreement between the parties.

Example : For type A inclusions taking

$n_1$  as the number of fields of index 0.5

$n_2$  as the number of fields of index 1.0

$n_3$  as the number of fields of index 1.5

$n_4$  as the number of fields of index 2.0

$n_5$  as the number of fields of index 2.5

$n_6$  as the number of fields of index 3.0

then

$$i_{\text{tot}} = (n_1 \times 0.5) + (n_2 \times 1.0) + (n_3 \times 1.5) + (n_4 \times 2.0) + (n_5 \times 2.5) + (n_6 \times 3.0)$$

$$i_{\text{moy}} = \frac{i_{\text{tot}}}{N}$$

where  $N$  is the total number of fields observed.

A typical result is given in annex C.

**7 Test report** The test report shall contain the following information:

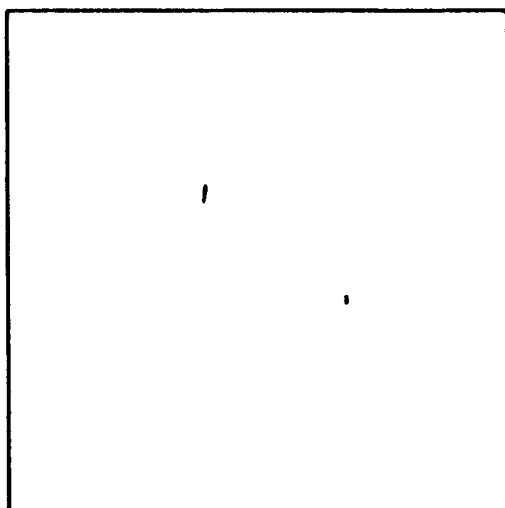
- a) reference to this Standard, i.e. **JIS G 0555**;
- b) the type or symbol of material and the cast number;
- c) the symbol of the product and its dimensions;
- d) the type of sampling and position of the area examined;
- e) the method selected (method of observation, method of examination, method of expressing chart diagrams and results);
- f) the magnification if greater than 100×;
- g) the number of observed fields or the total area examined;
- h) the results of the examination (including the reference number, size and type of oversized inclusions or stringers);
- i) statement of subscripts used to define any non-traditional inclusion types;
- j) report number and date;
- k) name of operator.

**Annex A (normative)**  
**Chart diagrams for inclusion groups A, B, C, D and DS**

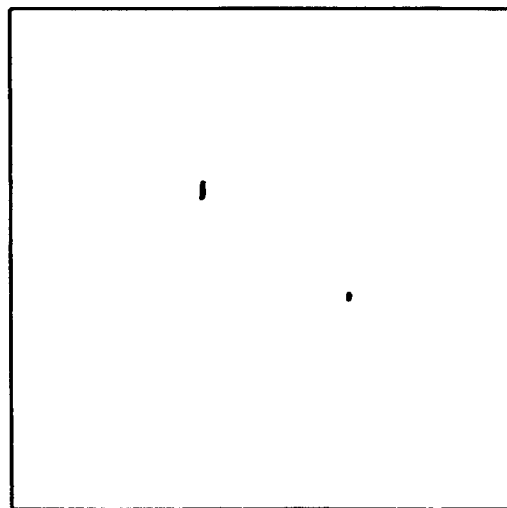
**A**  
**(Sulfide type)**

| Fine series                                       | Minimum<br>total length | Thick series                                    |
|---------------------------------------------------|-------------------------|-------------------------------------------------|
| Thickness $\geq 2 \mu\text{m}$ to $4 \mu\text{m}$ |                         | Thickness $> 4 \mu\text{m}$ to $12 \mu\text{m}$ |

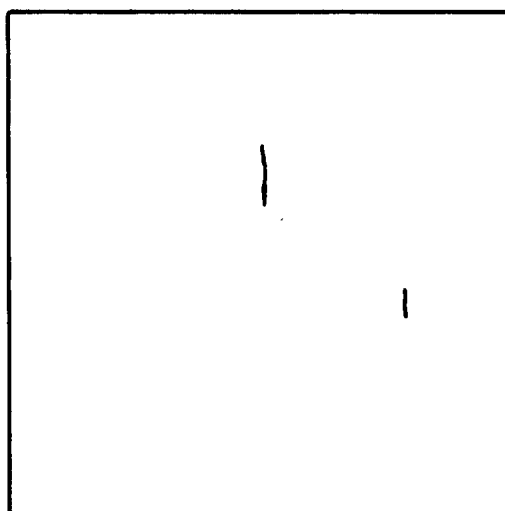
$i = 0,5$



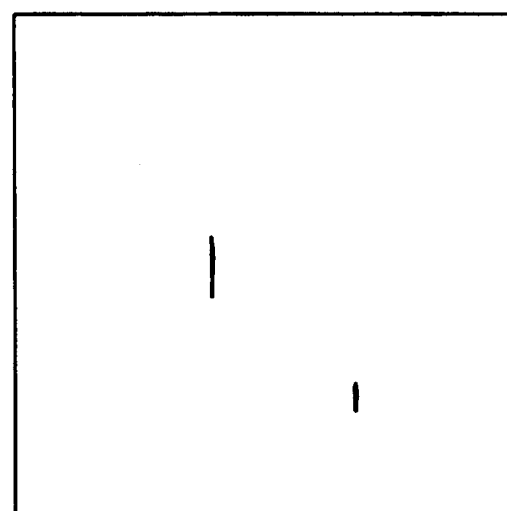
$37 \mu\text{m}$



$i = 1$

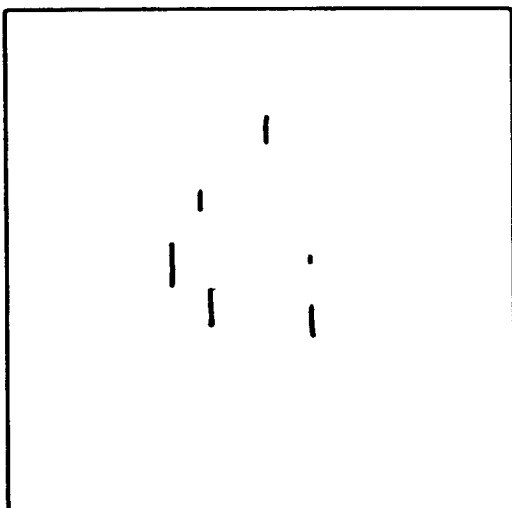


$127 \mu\text{m}$

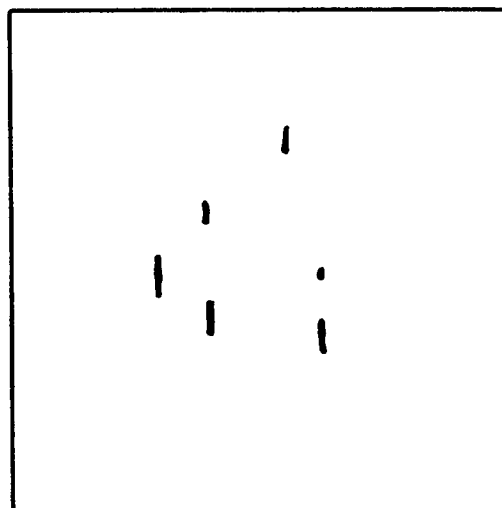


Magnification =  $100\times$

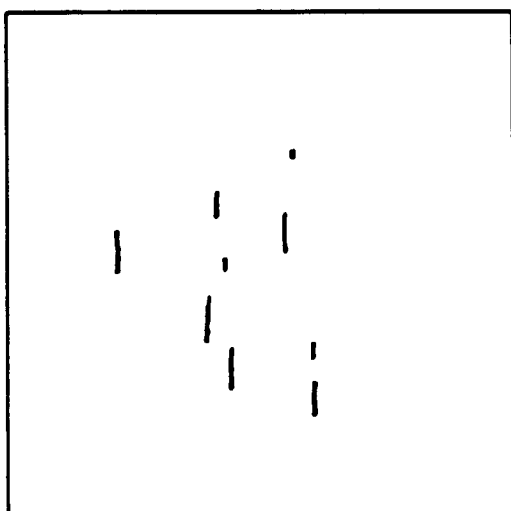
$i = 1,5$



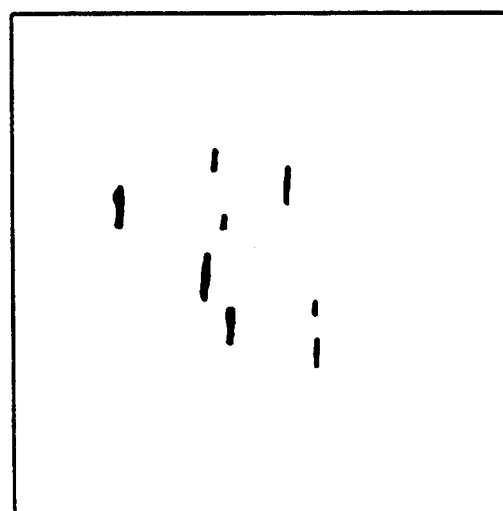
261  $\mu\text{m}$



$i = 2$

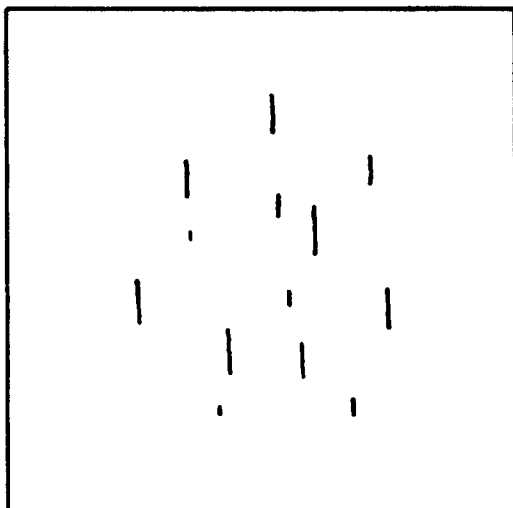


436  $\mu\text{m}$

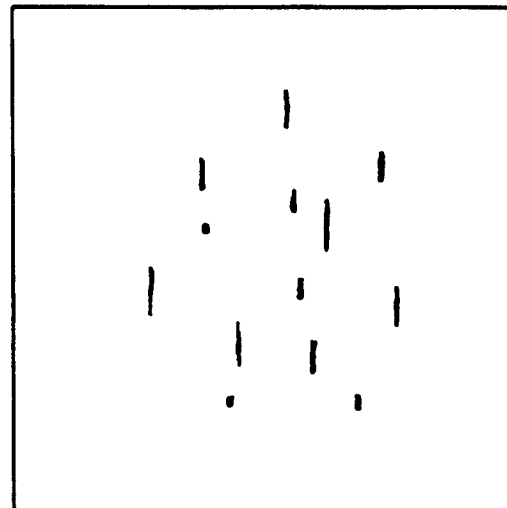


Magnification = 100×

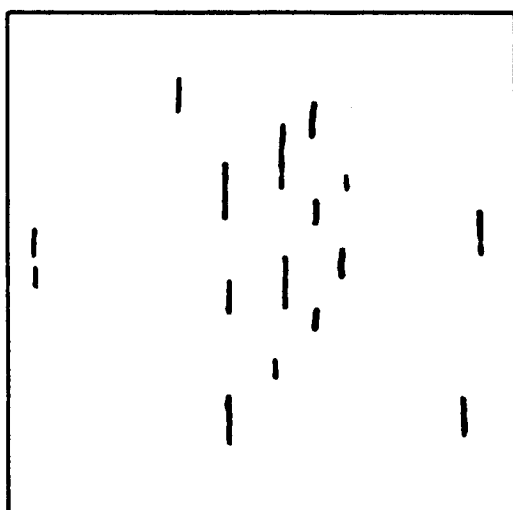
$i = 2,5$



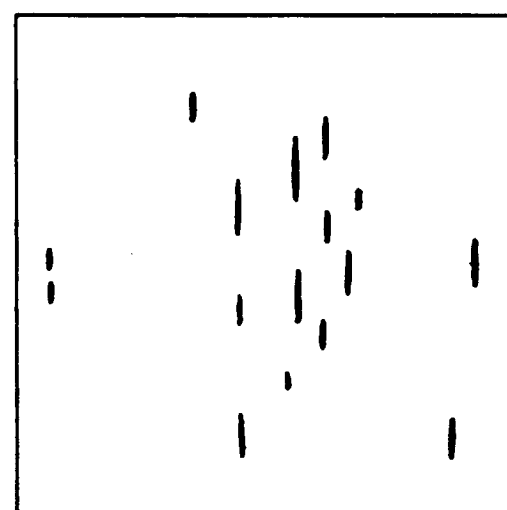
649  $\mu\text{m}$



$i = 3$



898  $\mu\text{m}$



Magnification = 100 $\times$

B  
(Aluminate type)

Fine series

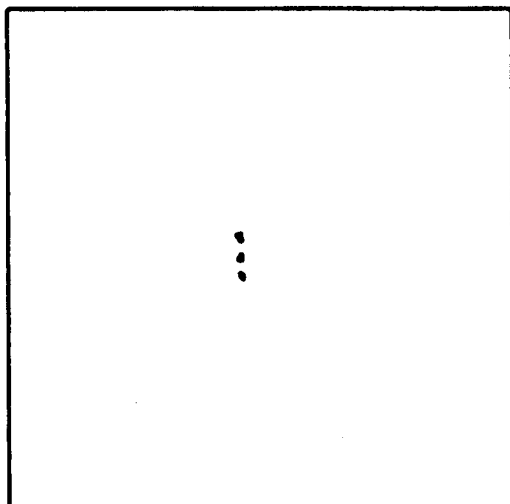
Thickness  $\geq 2 \mu\text{m}$  to  $9 \mu\text{m}$

Minimum  
total length

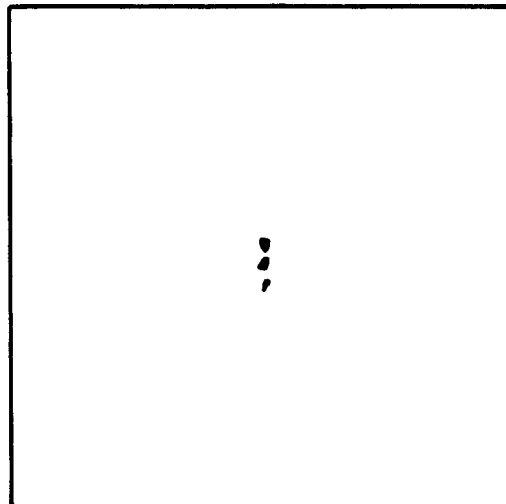
Thick series

Thickness  $> 9 \mu\text{m}$  to  $15 \mu\text{m}$

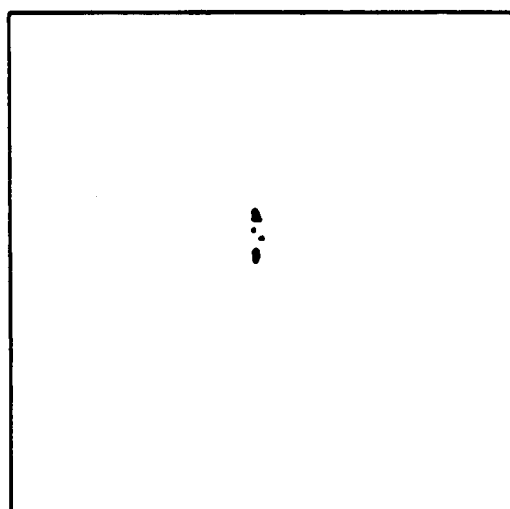
$i = 0,5$



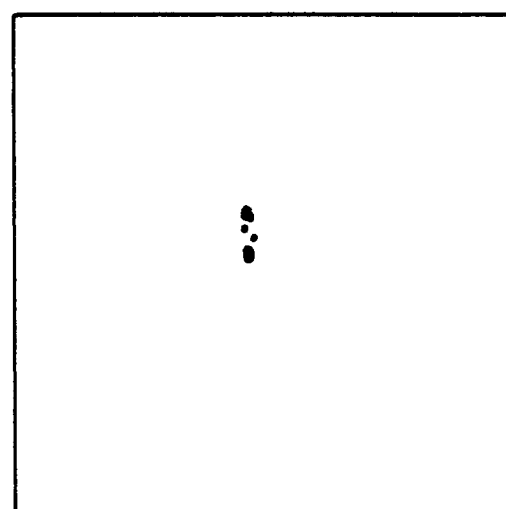
17  $\mu\text{m}$



$i = 1$

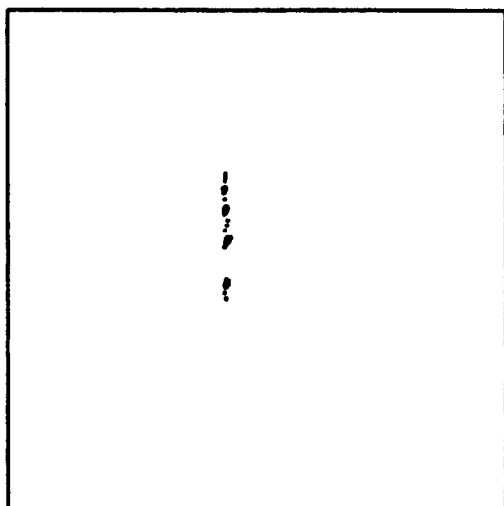


77  $\mu\text{m}$

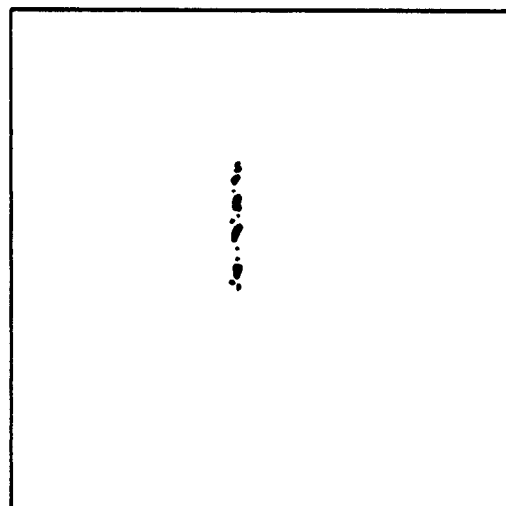


Magnification =  $100\times$

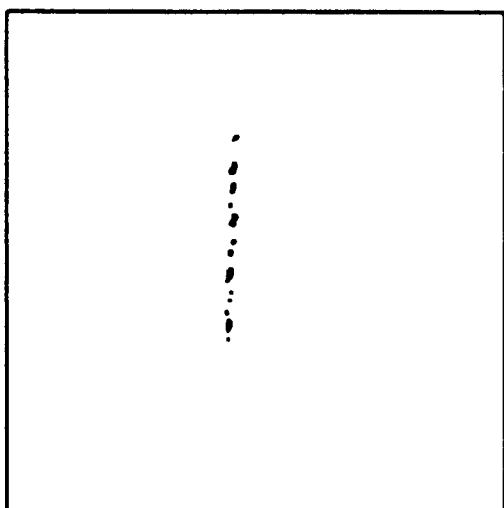
$i = 1,5$



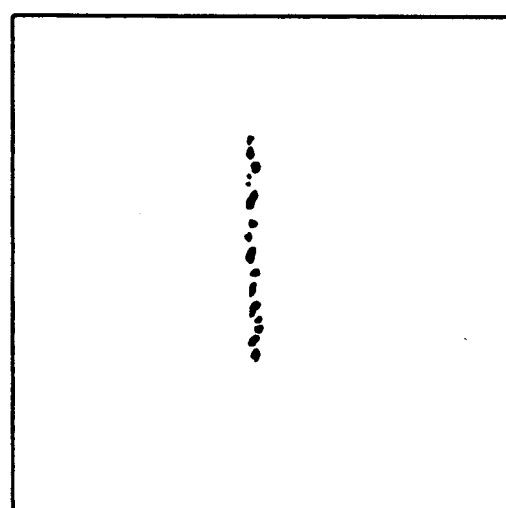
184  $\mu\text{m}$



$i = 2$

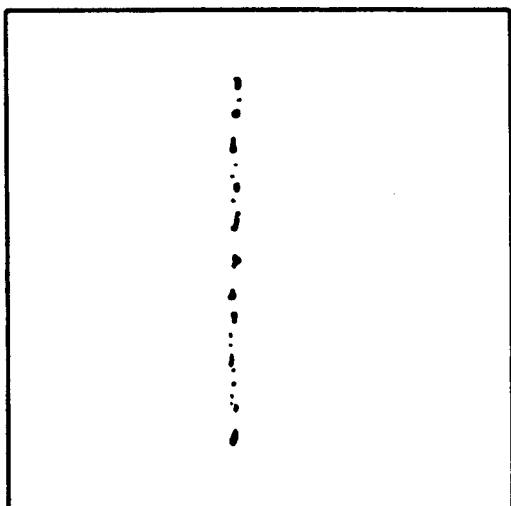


343  $\mu\text{m}$

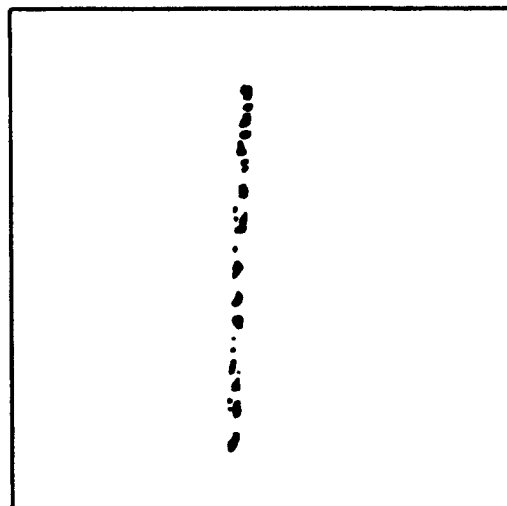


Magnification = 100×

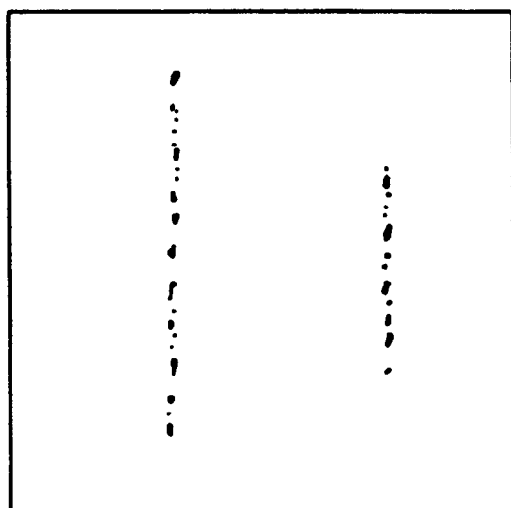
$i = 2,5$



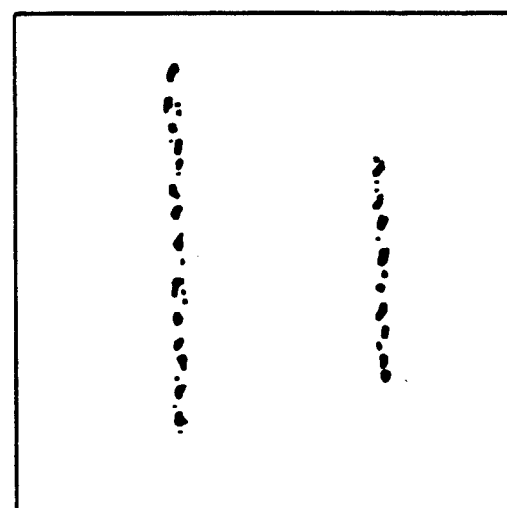
555  $\mu\text{m}$



$i = 3$



822  $\mu\text{m}$



Magnification = 100 $\times$

C  
(Silicate type)

Fine series

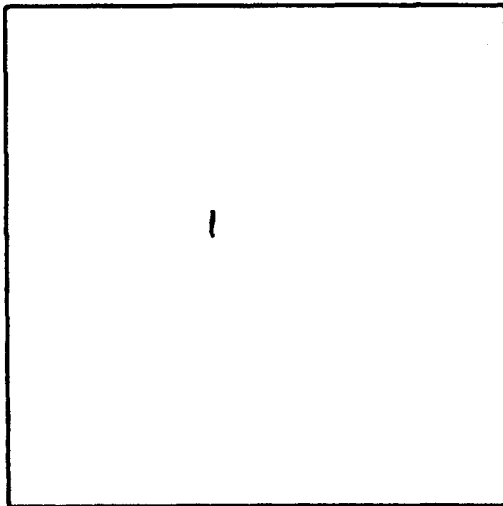
Thickness  $\geq 2 \mu\text{m}$  to  $5 \mu\text{m}$

Minimum  
total length

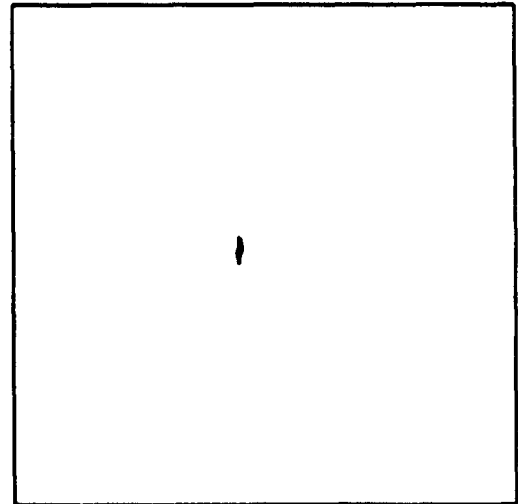
Thick series

Thickness  $> 5 \mu\text{m}$  to  $12 \mu\text{m}$

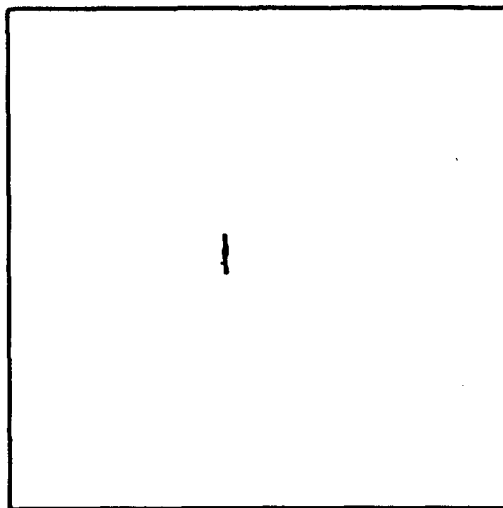
$i = 0,5$



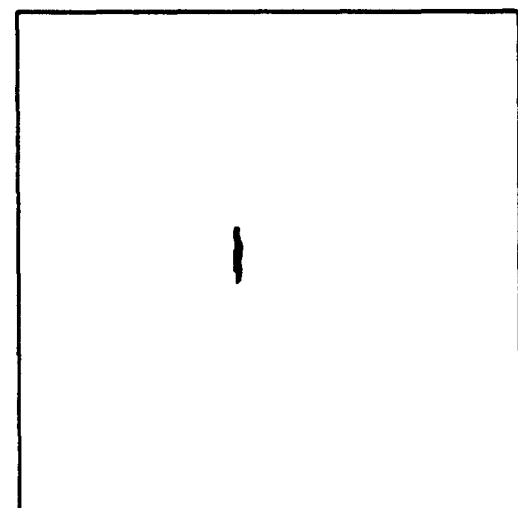
$18 \mu\text{m}$



$i = 1$

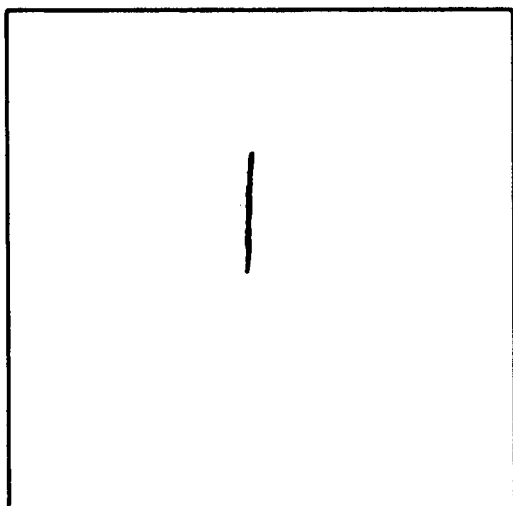


$76 \mu\text{m}$

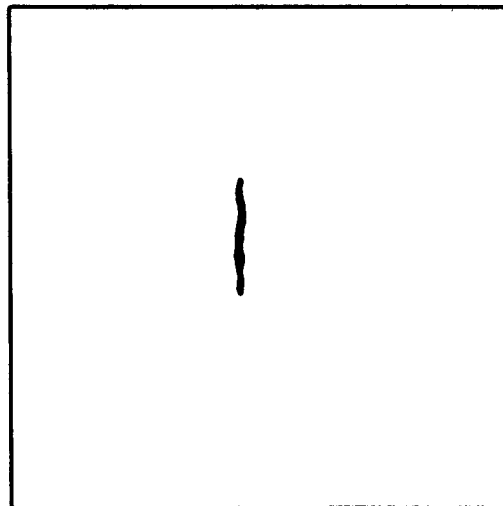


Magnification =  $100\times$

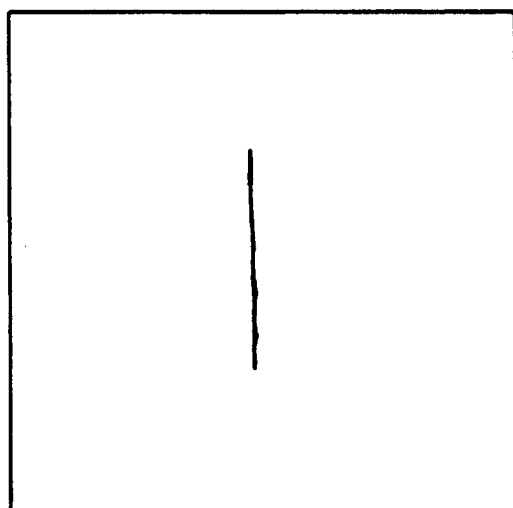
$i = 1,5$



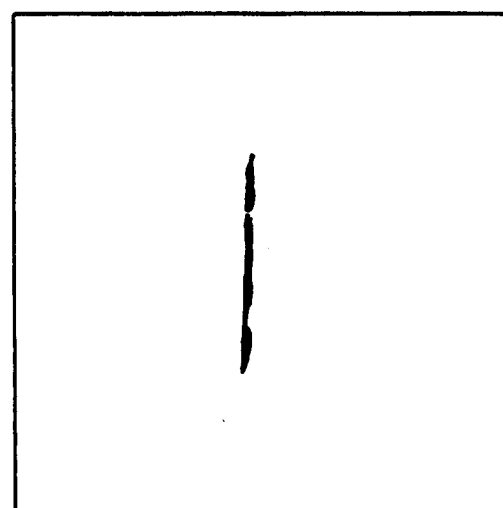
176  $\mu\text{m}$



$i = 2$

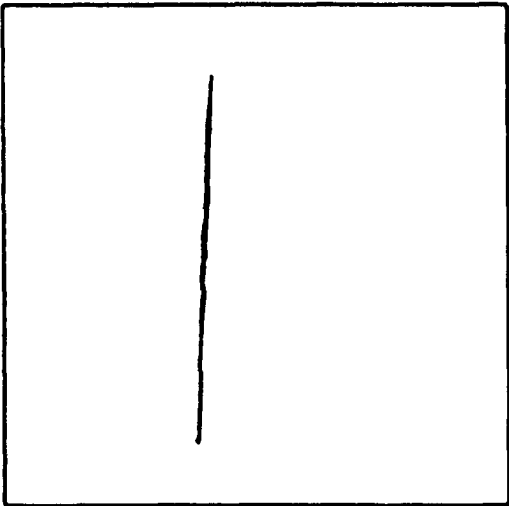


320  $\mu\text{m}$

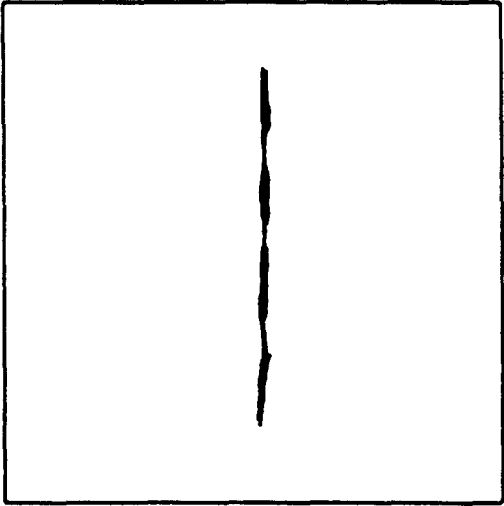


Magnification = 100×

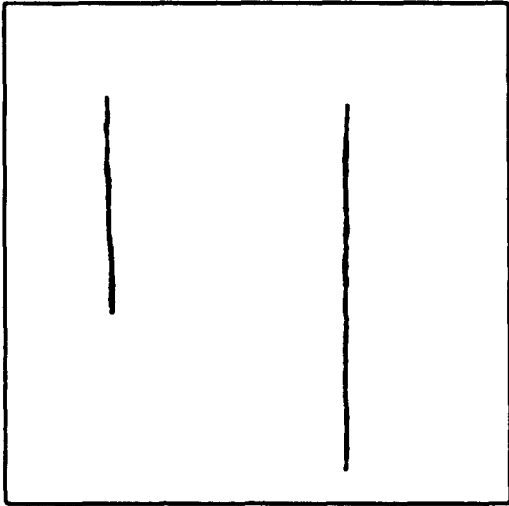
$i = 2,5$



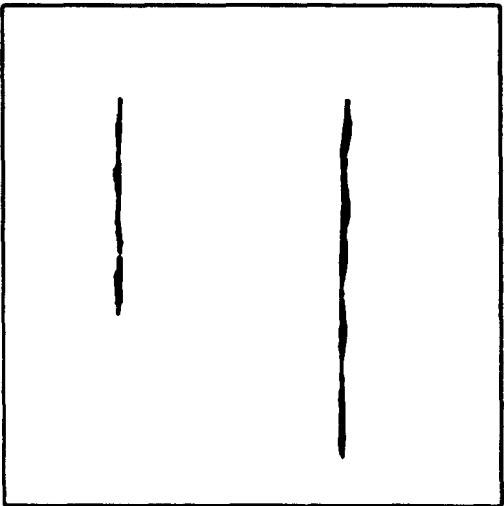
510  $\mu\text{m}$



$i = 3$



746  $\mu\text{m}$



Magnification = 100×

D  
(Globular type oxides)

Fine series

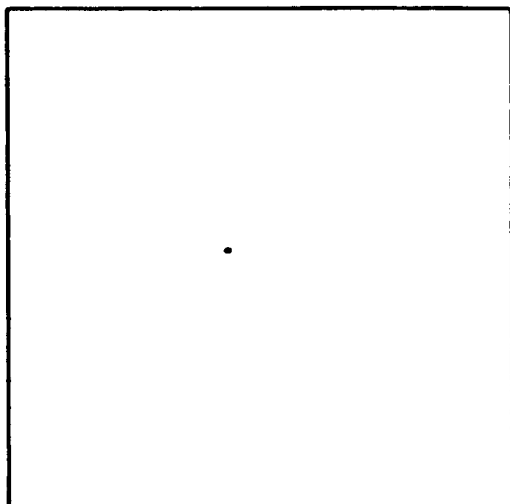
Thickness  $\geq 3 \mu\text{m}$  to  $8 \mu\text{m}$

Minimum  
total length

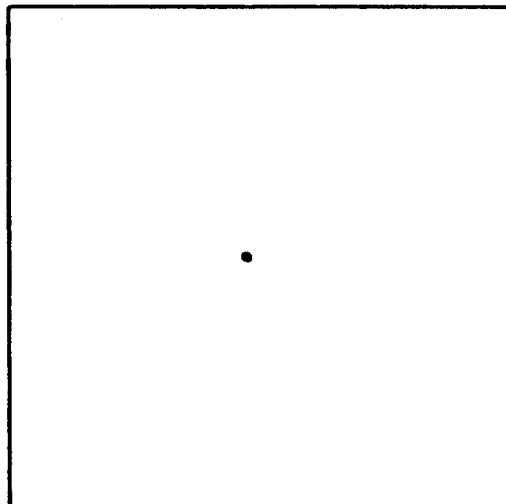
Thick series

Thickness  $> 8 \mu\text{m}$  to  $13 \mu\text{m}$

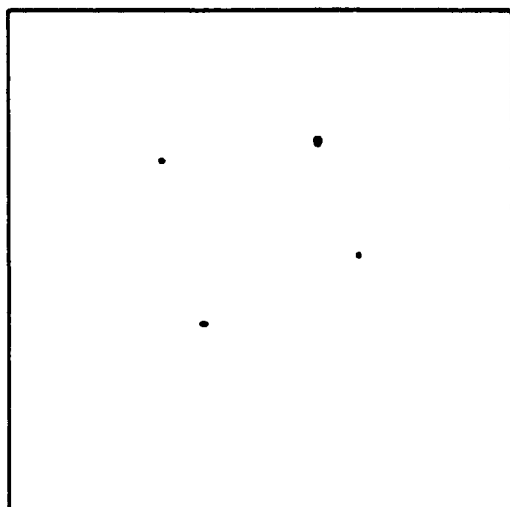
$i = 0,5$



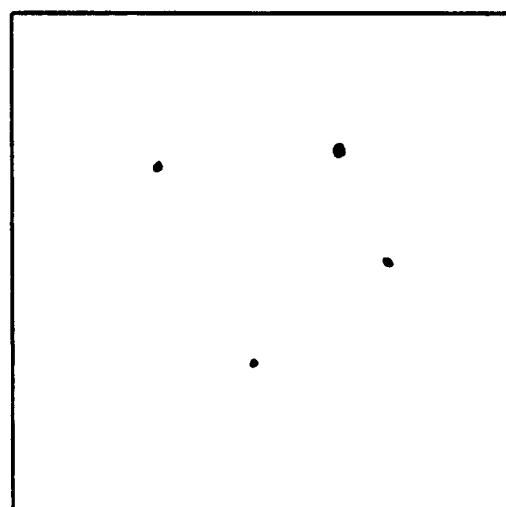
1



$i = 1$

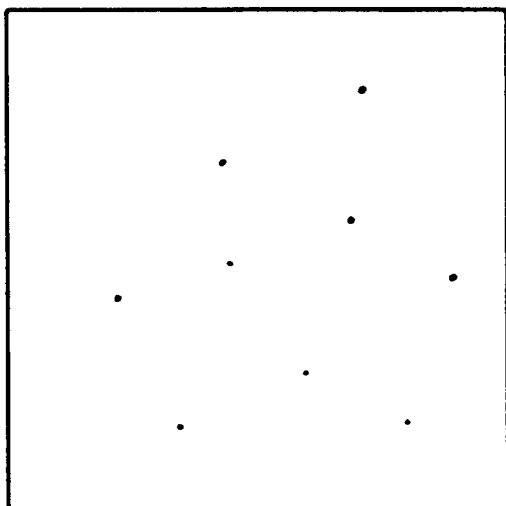


4

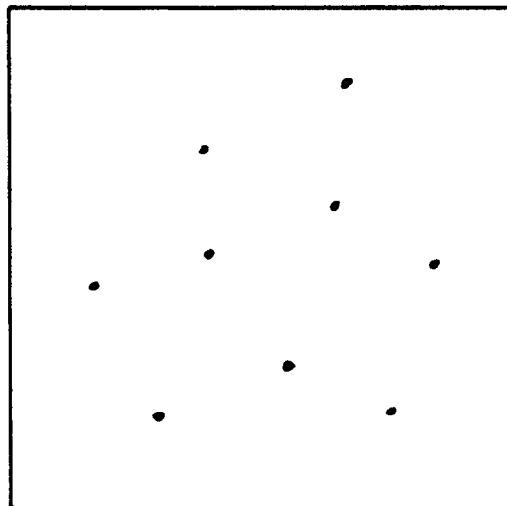


Magnification =  $100\times$

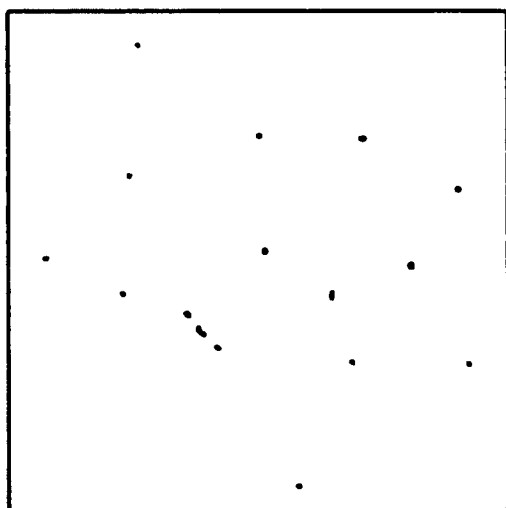
$i = 1,5$



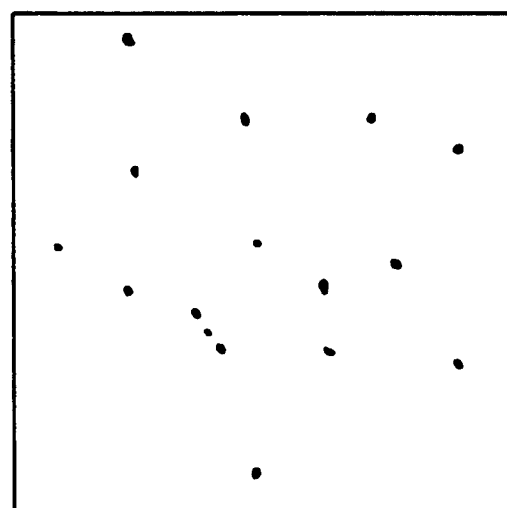
9



$i = 2$

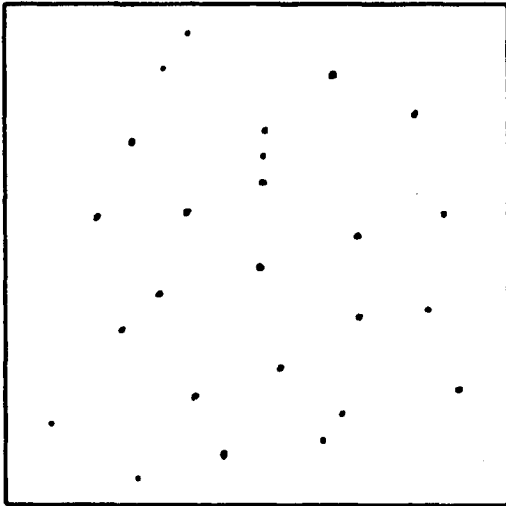


16

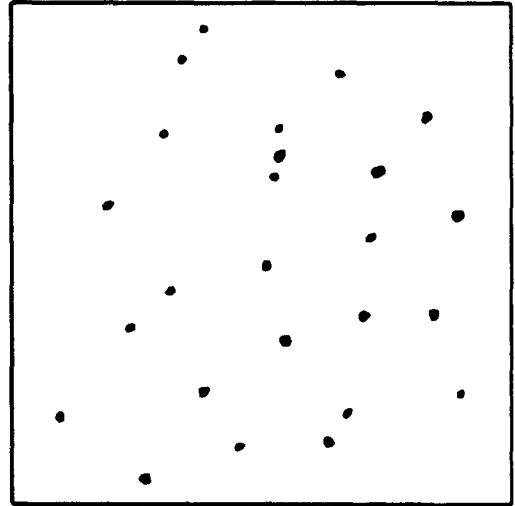


Magnification = 100×

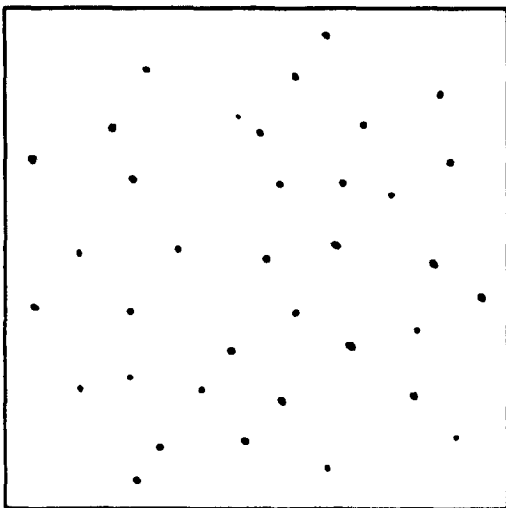
$i = 2,5$



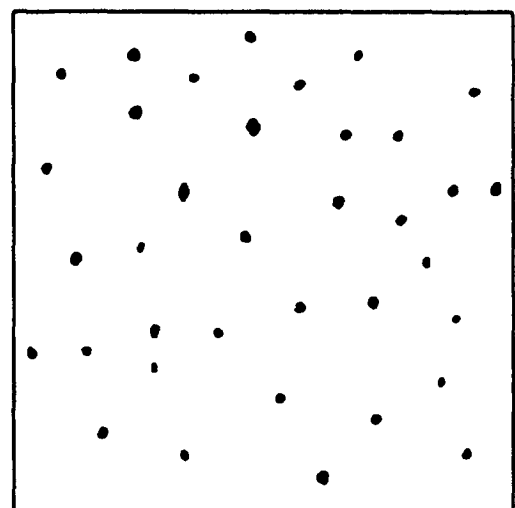
25



$i = 3$



36

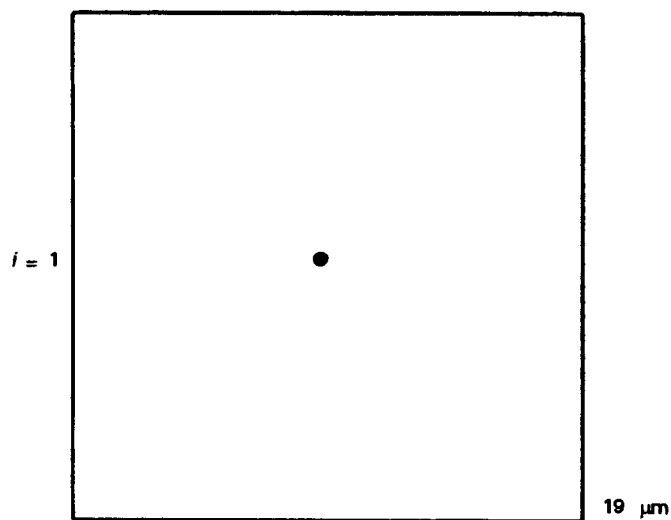
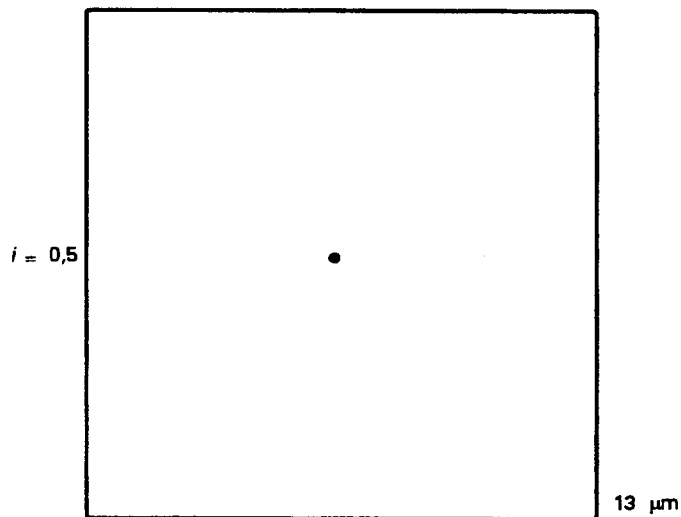


Magnification = 100×

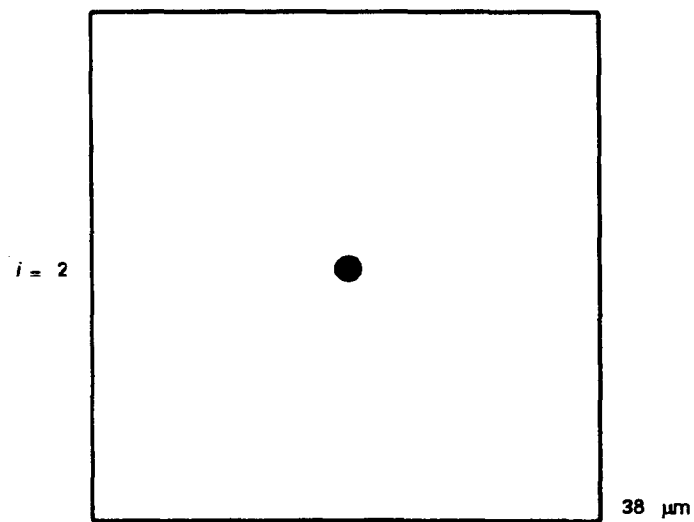
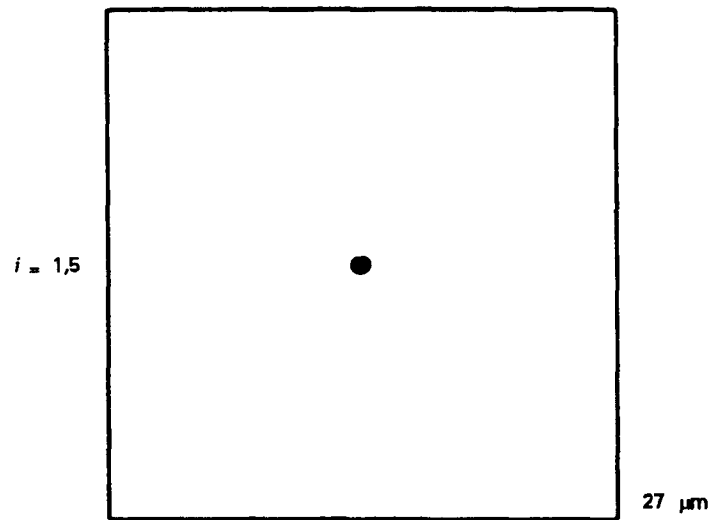
DS  
(Single globular inclusion)

Diameter  $> 13\text{ }\mu\text{m}$  to  $76\text{ }\mu\text{m}$

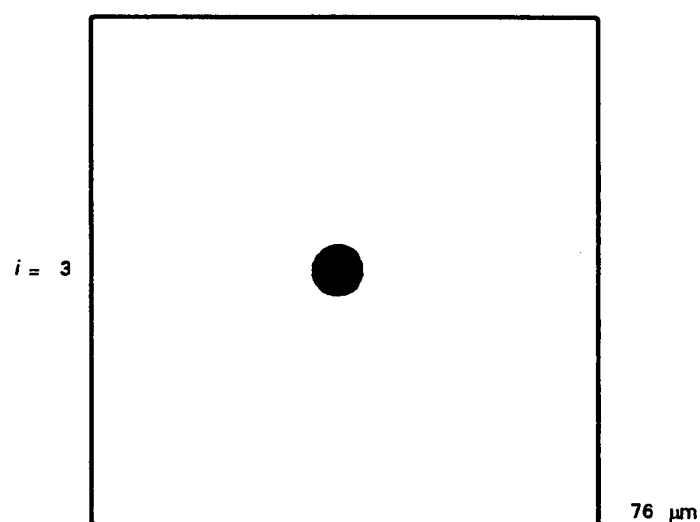
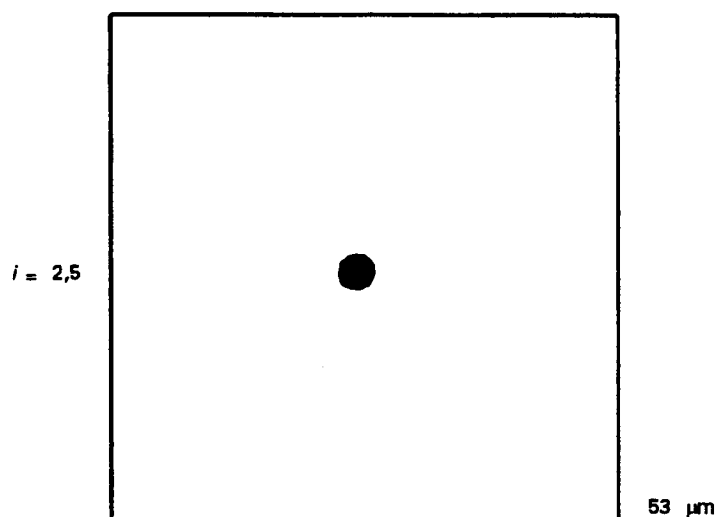
Minimum diameter



Magnification =  $100\times$



Magnification =  $100\times$

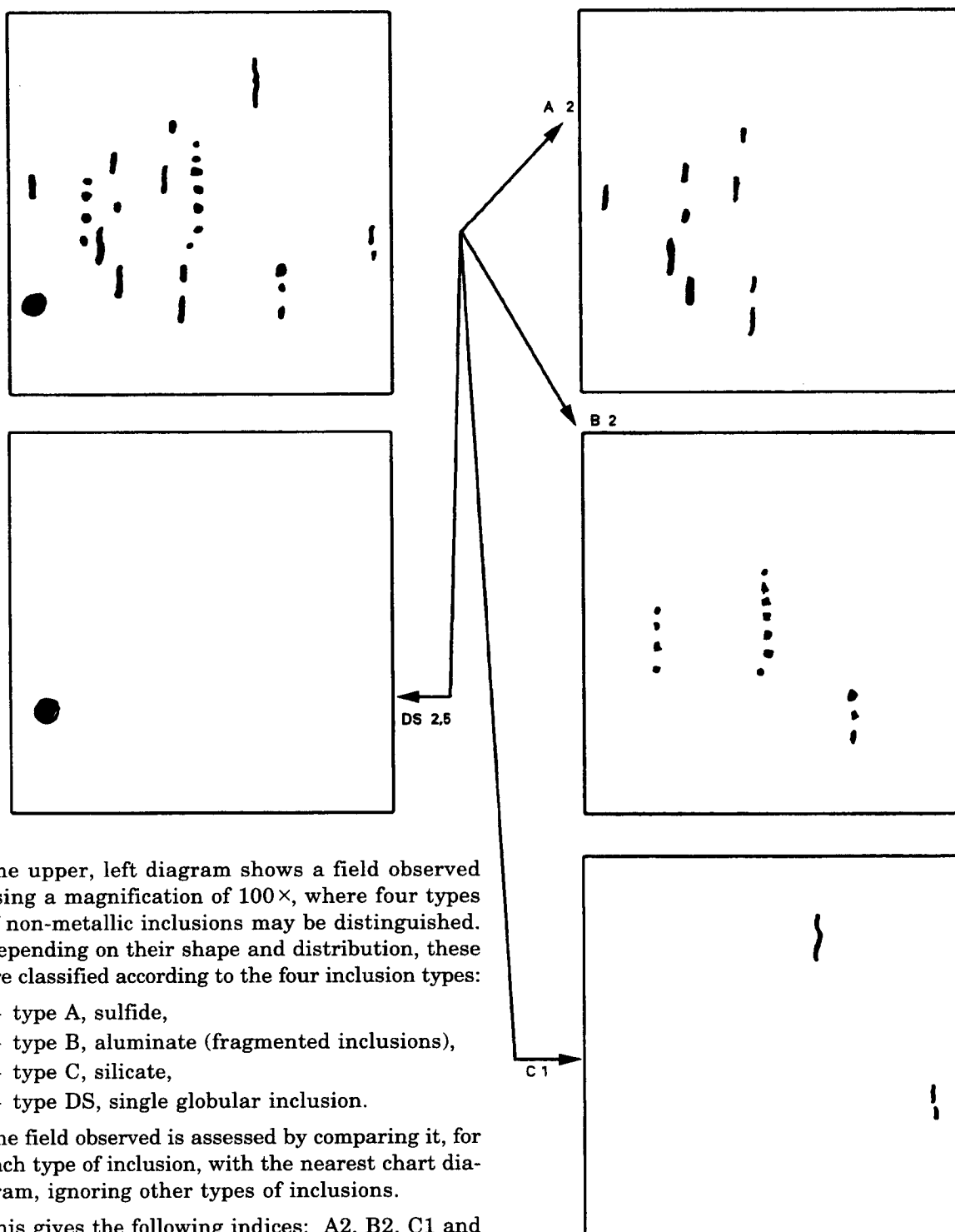


Magnification = 100×

## Annex B (informative)

### Assessment of a field and of oversized inclusions or stringers

#### B.1 Example of assessment of a field (see Fig. B.1)



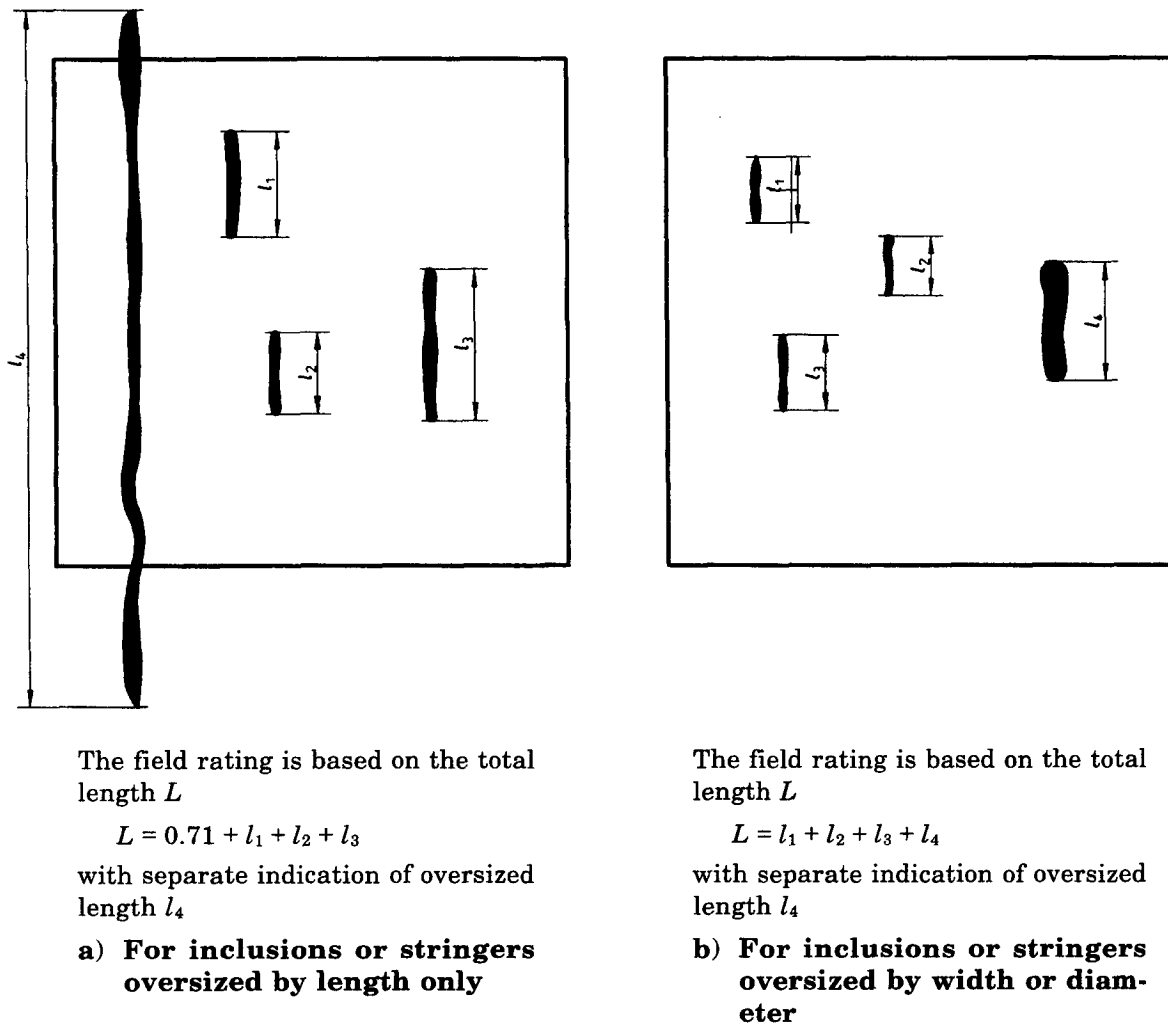
**Figure B.1 Field assessment**

**B.2 Example of assessment of oversized inclusions or stringers** If the inclusion or stringer is oversized by length only, the portion of the inclusion or stringer within the field for method B, or 0.710 mm for method A, will be added to the length of any other inclusions of the same type in the same field [see Figure B.2 a)].

If the inclusion or stringer is oversized by width or diameter (type D inclusions), the inclusion should be part of the thick series rating for that field.

For the type D inclusion, if the number of inclusions is greater than 49, the index can be calculated from the equation given in annex D.

For the type DS inclusion with a diameter greater than 0.107 mm, the index can be calculated from the equation given in annex D.



**Figure B.2 Field assessment with oversized inclusions on stringers**

### Annex C (informative)

#### Typical example of results

(the total number of fields showing the index, by type of inclusion, for a given number of fields observed)

**C.1 Indices according to field and type of inclusion** Table C.1 gives an example of the results of an assessment of this type, for a total of 20 observed fields, in order to simplify the lay-out of the examples. In general, a minimum of 100 fields are examined.

**Table C.1 Indices**

| Field | Type of inclusion |                |              |                |              |                |              |                | DS  |
|-------|-------------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|-----|
|       | A                 |                | B            |                | C            |                | D            |                |     |
|       | finer series      | thicker series | finer series | thicker series | finer series | thicker series | finer series | thicker series |     |
| 1     | —                 | 0.5            | 1            | —              | 0.5          | —              | —            | —              | —   |
| 2     | 0.5               | —              | —            | —              | 0.5          | —              | —            | —              | —   |
| 3     | 0.5               | —              | 0.5          | —              | —            | 0.5            | —            | —              | 0.5 |
| 4     | 1                 | —              | —            | 0.5            | 1.5          | —              | —            | 0.5            | —   |
| 5     | —                 | —              | —            | 1.5            | —            | 1              | —            | —              | —   |
| 6     | 1.5               | —              | —            | —              | —            | —              | 0.5          | —              | 1   |
| 7     | —                 | 1s             | 1.5          | —              | —            | 0.5            | —            | —              | —   |
| 8     | —                 | 1              | —            | 1              | 1            | —              | —            | 1              | —   |
| 9     | 0.5               | —              | 0.5          | —              | 0.5          | —              | —            | —              | —   |
| 10    | —                 | 0.5            | 1            | —              | 0.5          | —              | —            | —              | —   |
| 11    | 1                 | —              | 0.5          | —              | —            | 0.5            | —            | —              | 1   |
| 12    | 0.5               | —              | —            | —              | —            | —              | —            | —              | —   |
| 13    | —                 | —              | —            | 0.5            | —            | 1.5            | 1            | —              | —   |
| 14    | 2                 | —              | —            | 1              | —            | —              | —            | —              | —   |
| 15    | —                 | —              | —            | —              | 0.5          | —              | —            | —              | —   |
| 16    | 0.5               | —              | 1            | —              | —            | 1              | —            | —              | —   |
| 17    | 0.5               | —              | 0.5          | —              | —            | —              | —            | 0.5            | 1.5 |
| 18    | —                 | —              | —            | 1.5            | 1            | —              | —            | —              | —   |
| 19    | —                 | 2              | —            | 3              | 0.5          | —              | 0.5          | —              | —   |
| 20    | —                 | —              | 0.5          | —              | —            | 0.5            | —            | —              | —   |

**C.2 Total number of fields per type of inclusion** On the basis of these results it is possible to determine the total number of fields for the various indices and inclusion types. Table C.2 below gives the values for the total number of fields.

**Table C.2 Total number of fields**

| Field | Type of inclusion |                |              |                |              |                |              |                | DS |
|-------|-------------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|----|
|       | A                 |                | B            |                | C            |                | D            |                |    |
|       | finer series      | thicker series | finer series | thicker series | finer series | thicker series | finer series | thicker series |    |
| 0.5   | 6                 | 2              | 5            | 2              | 6            | 4              | 2            | 2              | 1  |
| 1     | 2                 | 1              | 3            | 2              | 2            | 2              | 1            | 1              | 2  |
| 1.5   | 1                 | 0              | 1            | 2              | 1            | 1              | 0            | 0              | 1  |
| 2     | 1                 | 1              | 0            | 0              | 0            | 0              | 0            | 0              | 0  |
| 2.5   | 0                 | 0              | 0            | 0              | 0            | 0              | 0            | 0              | 0  |
| 3     | 0                 | 0              | 0            | 1              | 0            | 0              | 0            | 0              | 0  |

Remarks : Inclusions having a length greater than the dimension of the field, or a width or a diameter greater than indicated in table 2 shall be rated using the chart diagrams and reported separately in the test report.

**C.3 Calculation of total index,  $i_{tot}$ , and mean index,  $i_{moy}$**  Using the total numbers of fields given in table C.2 it is possible to calculate the corresponding total and mean indices for each inclusion type.

**C.3.1 For type A inclusions**

a) Fine series

$$i_{tot} = (6 \times 0.5) + (2 \times 1) + (1 \times 1.5) + (1 \times 2) = 8.5$$

$$i_{moy} = \frac{i_{tot}}{N} = \frac{8.5}{20} = 0.425$$

where  $N$  is the total number of fields observed

b) Thick series

$$i_{tot} = (2 \times 0.5) + (1 \times 1) + (1 \times 2) = 4$$

$$i_{moy} = \frac{4}{20} = 0.20 \text{ with indication of 1 s}$$

**C.3.2 For type B inclusions**

a) Fine series

$$i_{tot} = (5 \times 0.5) + (3 \times 1) + (1 \times 1.5) = 7$$

$$i_{moy} = \frac{7}{20} = 0.35$$

b) Thick series

$$i_{tot} = (2 \times 0.5) + (2 \times 1) + (2 \times 1.5) + (1 \times 3) = 9$$

$$i_{moy} = \frac{9}{20} = 0.45$$

### C.3.3 For type C inclusions

a) Fine series

$$i_{\text{tot}} = (6 \times 0.5) + (2 \times 1) + (1 \times 1.5) = 6.5$$

$$i_{\text{moy}} = \frac{6.5}{20} = 0.325$$

b) Thick series

$$i_{\text{tot}} = (4 \times 0.5) + (2 \times 1) + (1 \times 1.5) = 5.5$$

$$i_{\text{moy}} = \frac{5.5}{20} = 0.275$$

### C.3.4 For type D inclusions

a) Fine series

$$i_{\text{tot}} = (2 \times 0.5) + (1 \times 1) = 2$$

$$i_{\text{moy}} = \frac{2}{20} = 0.10$$

b) Thick series

$$i_{\text{tot}} = (2 \times 0.5) + (2 \times 1) = 3$$

$$i_{\text{moy}} = \frac{3}{20} = 0.15$$

### C.3.5 For type DS inclusions

$$i_{\text{tot}} = (1 \times 0.5) + (2 \times 1) + (1 \times 1.5) = 4$$

$$i_{\text{moy}} = \frac{4}{20} = 0.20$$

**C.4 Weighting factor** It is possible to use a weighting factor for each reference number in order to calculate global cleanness index based on the amount of inclusions. The weighting factors given in table C.3 may be used:

**Table C.3 Weighting factors**

| Index number<br><i>i</i> | Weighting factor<br><i>f<sub>i</sub></i> |
|--------------------------|------------------------------------------|
| 0.5                      | 0.05                                     |
| 1                        | 0.1                                      |
| 1.5                      | 0.2                                      |
| 2                        | 0.5                                      |
| 2.5                      | 1                                        |
| 3                        | 2                                        |

The cleanness index  $C_i$  is calculated by the following formula

$$C_i = \left[ \sum_{i=0.5}^3 f_i \times n_i \right] \times 1\,000/S$$

where

$f_i$  is the weighting factor;

$n_i$  is the number of fields of index  $i$ ;

$S$  is the total investigated area of the sample in square millimetres.

## **Annex D (informative)**

### **Relationship between chart diagram indices and inclusion measurements**

The relationship between the chart diagram indices and the inclusion measurements (length, diameter in  $\mu\text{m}$  or number per field) for inclusion groups A, B, C, D and DS are shown on the following graphs. The following equations can be used to calculate either the index from the measurement, or the inclusion measurement from the index, for example, if there is a need to calculate chart diagram numbers above 3.

#### **D.1 Calculation of chart diagram indices from measurements**

For group A sulfides, length in  $\mu\text{m}$  ( $L$ ):

$$\lg(i) = [0.560\ 5 \lg(L)] - 1.179$$

For group B aluminates, length in  $\mu\text{m}$  ( $L$ ):

$$\lg(i) = [0.462\ 6 \lg(L)] - 0.871$$

For group C silicates, length in  $\mu\text{m}$  ( $L$ ):

$$\lg(i) = [0.480\ 7 \lg(L)] - 0.904$$

For group D globular type oxides, number per field ( $n$ ):

$$\lg(i) = [0.5 \lg(n)] - 0.301$$

For group DS single globular inclusion, diameter in  $\mu\text{m}$  ( $d$ ):

$$i = [3.311 \lg(d)] - 3.22$$

Except for DS, the anti-log must be taken to obtain the  $i$ .

#### **D.2 Calculation of the inclusion measurement from the index**

For group A sulfides, length in  $\mu\text{m}$  ( $L$ ):

$$\lg(L) = [1.784 \lg(i)] + 2.104$$

For group B aluminates, length in  $\mu\text{m}$  ( $L$ ):

$$\lg(L) = [2.161\ 6 \lg(i)] + 1.884$$

For group C silicates, length in  $\mu\text{m}$  ( $L$ ):

$$\lg(L) = [2.08 \lg(i)] + 1.88$$

For group D globular type oxides, number per field ( $n$ ):

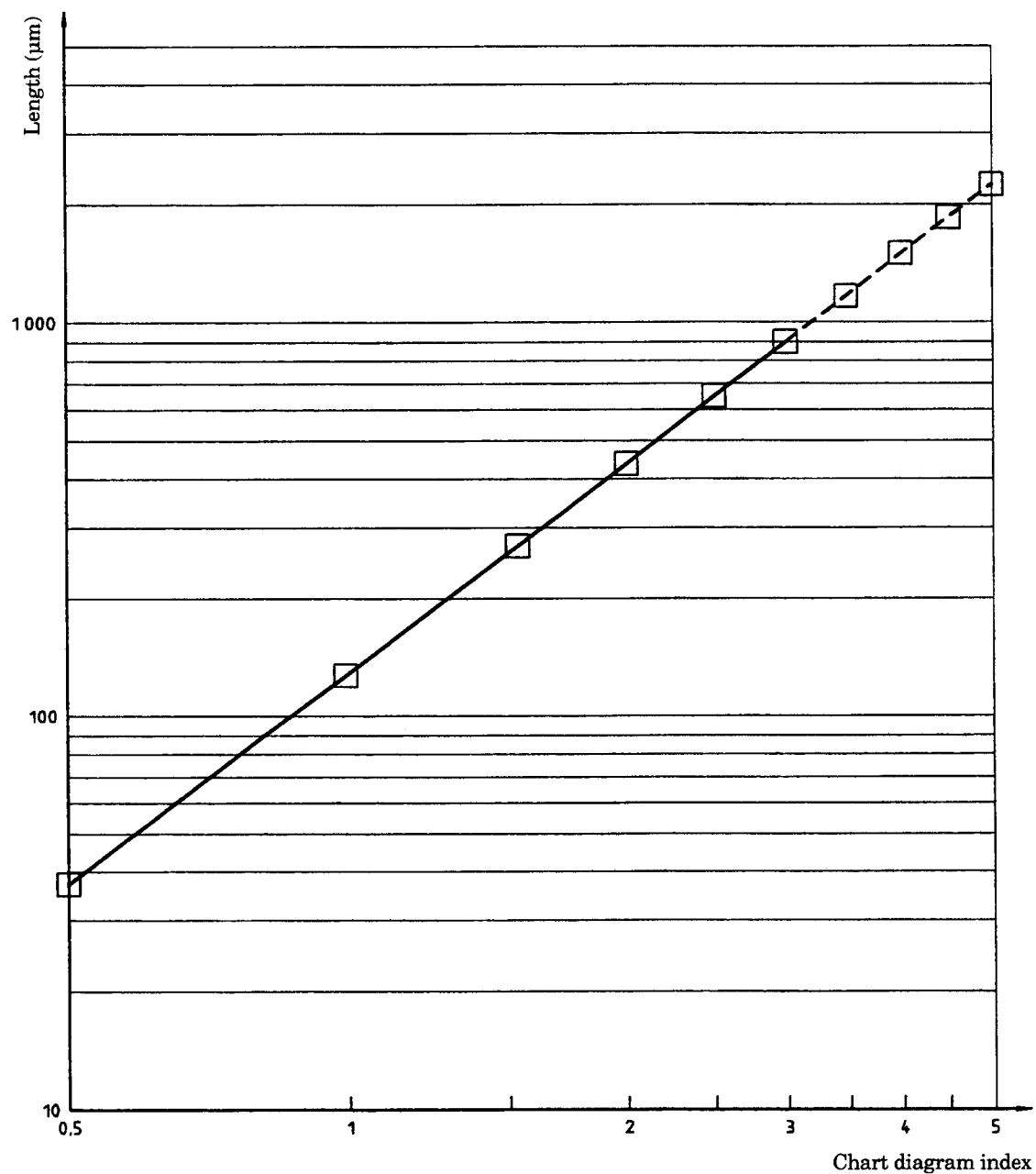
$$\lg(n) = [2 \lg(i)] + 0.602$$

For group DS single globular inclusion, diameter in  $\mu\text{m}$  ( $d$ ):

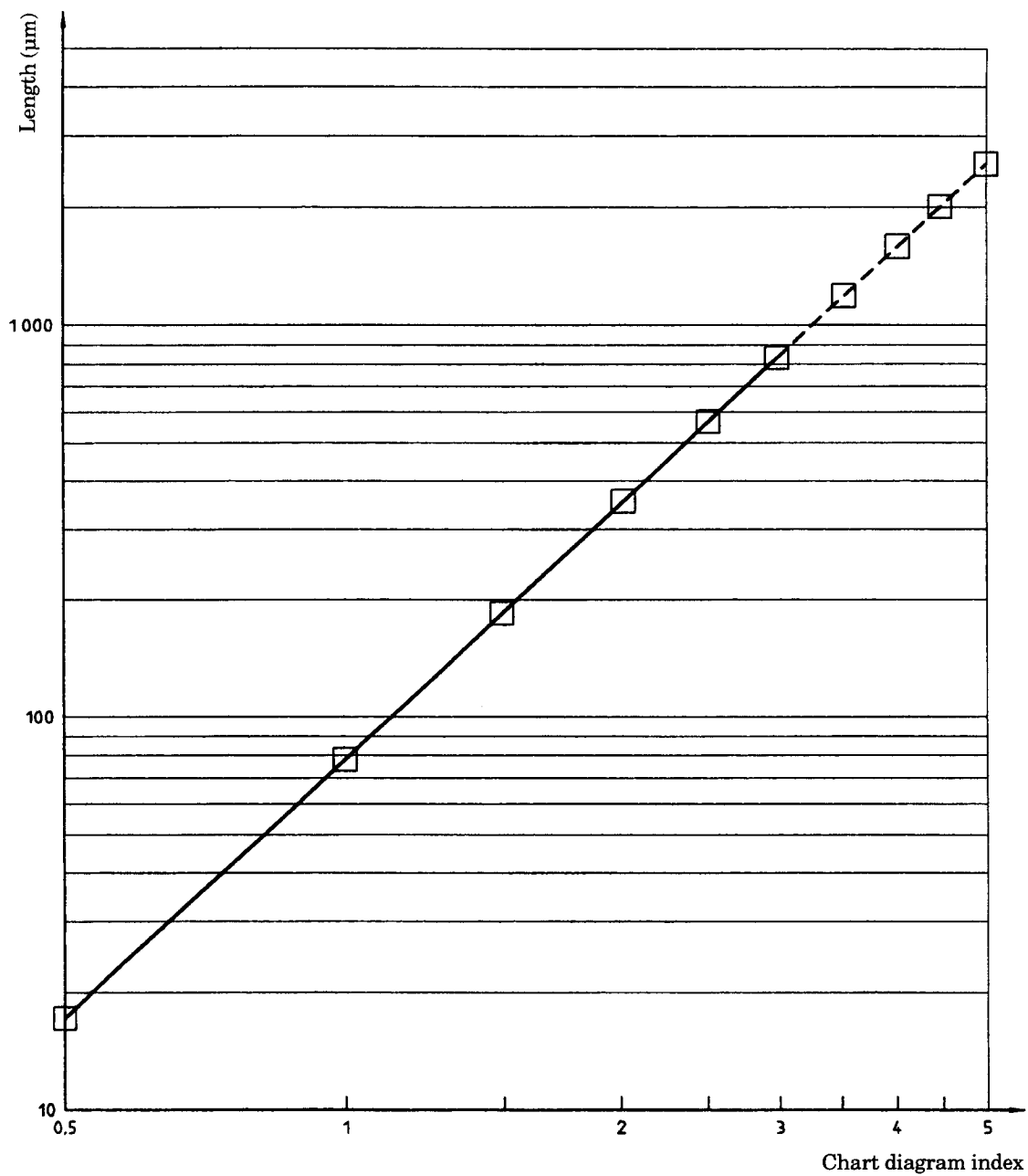
$$\lg(d) = [0.302 i] + 0.972$$

The anti-log must be taken to obtain the measurement values.

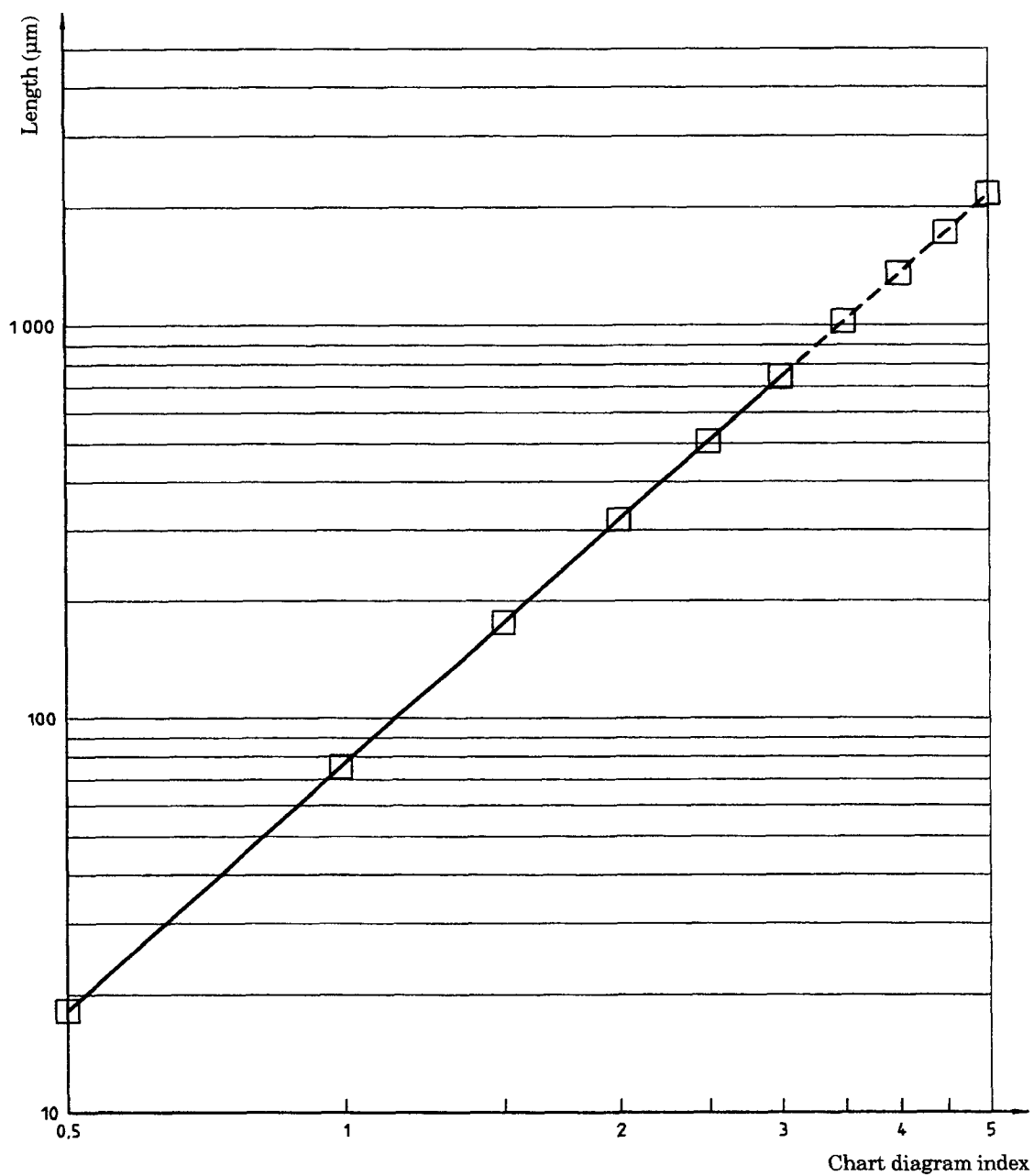
For the above linear regression equations, the  $R^2$  values are all above 0.999 9.



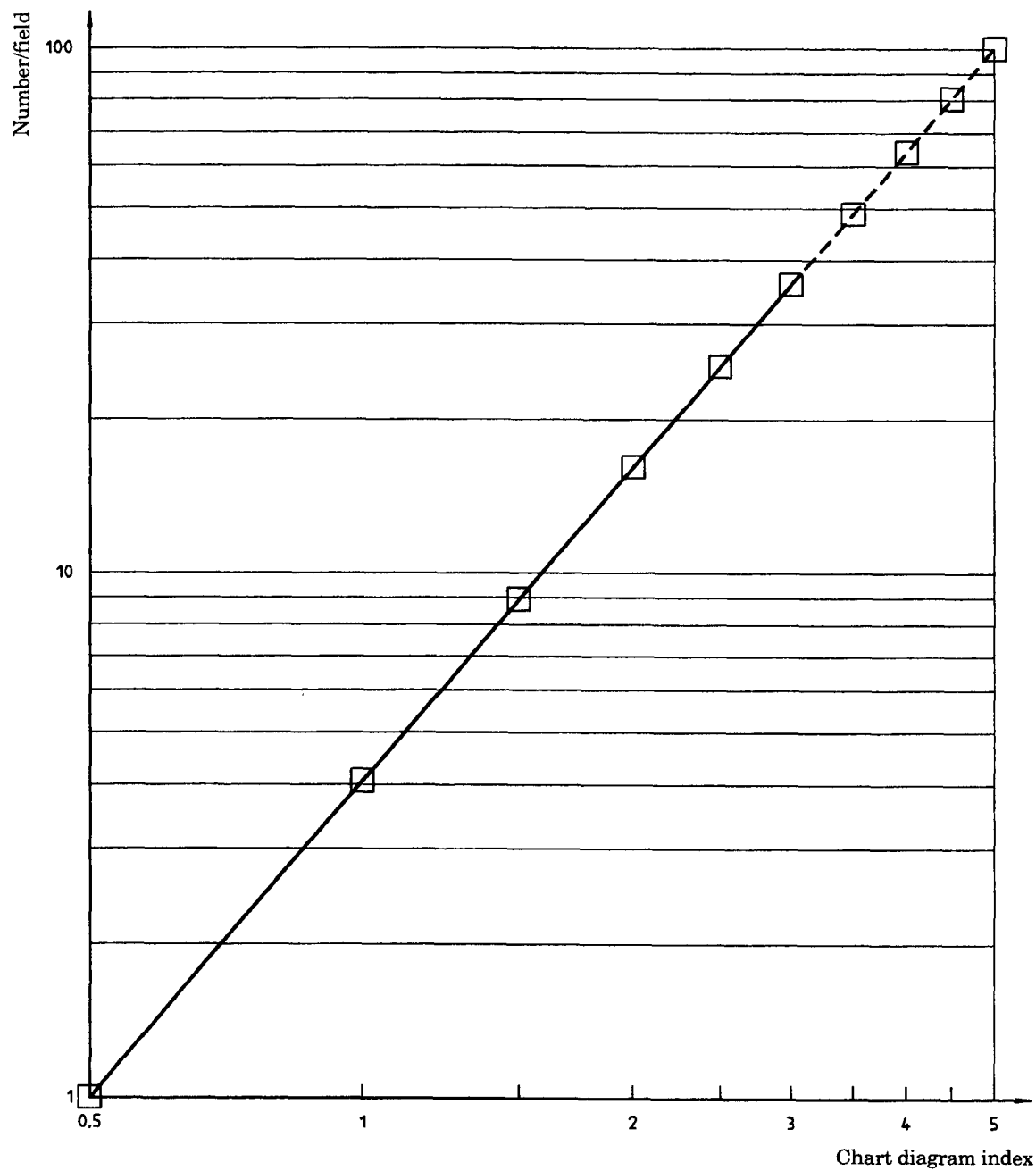
**Figure D.1 Group A: sulfide type**



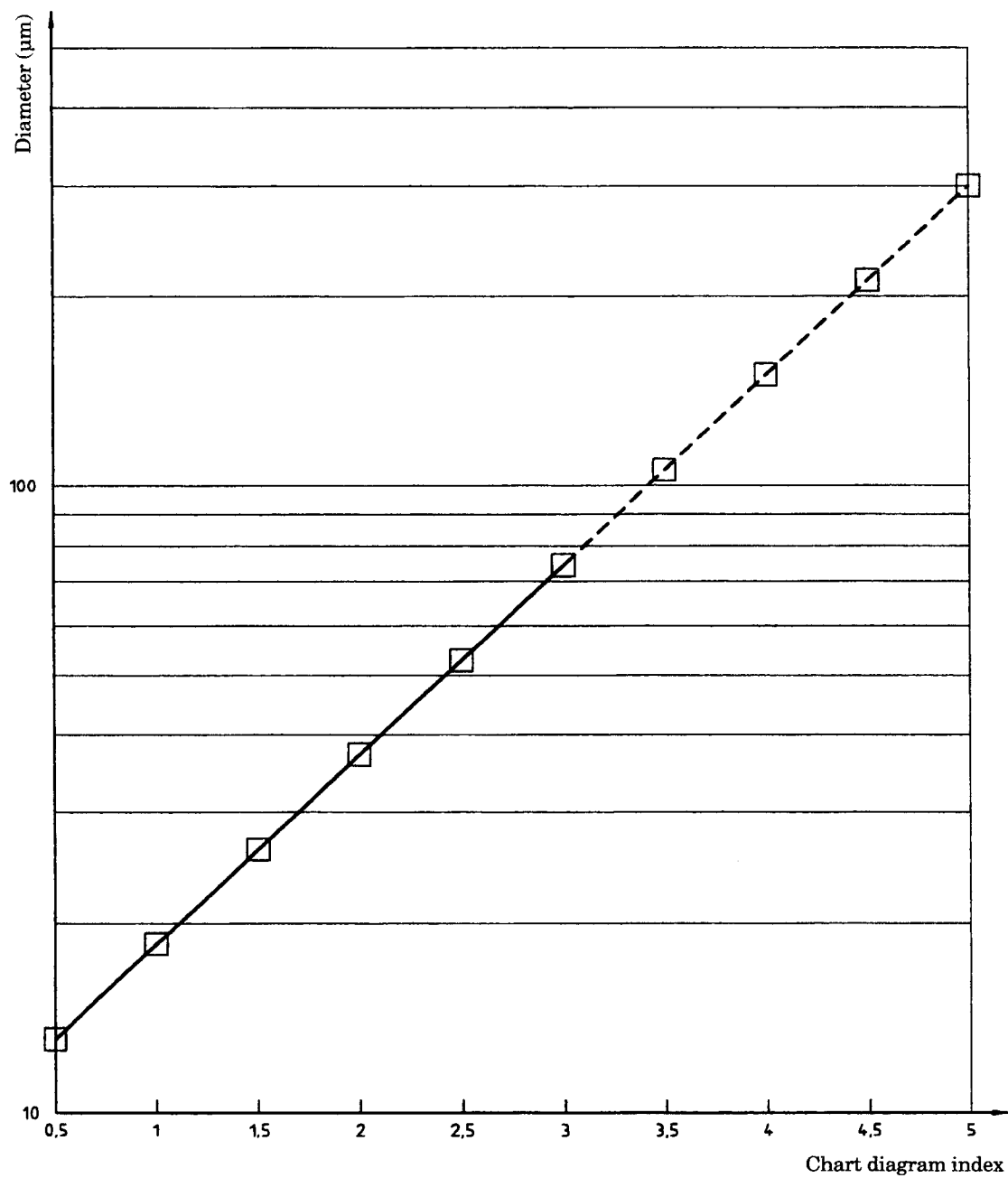
**Figure D.2 Group B: aluminate type**



**Figure D.3 Group C: silicate type**



**Figure D.4 Group D: globular type oxides**



**Figure D.5 Group DS: single globular inclusion**

## Annex 1 (normative)

### Microscopic testing method for non-metallic inclusions by point counting method

**1 Principle** A specific test piece is cut out from a specimen and finished by grinding to the test plane of a specific size. Thereafter, the classification of an inclusion and its area percentage are measured by examination with a microscope.

**2 Normative references** The following standard contains provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent edition of the standard (including amendments) indicated below shall be applied.

JIS G 0202 *Glossary of terms used in iron and steel (testing)*

**3 Definitions** Definitions of principal terms used in this Standard shall be in accordance with **JIS G 0202**. The rest shall be as follows:

a) **Point counting method** The method wherein a glass plate having specific grating lines is inserted into the eyepiece of a microscope, the test plane is examined with the microscope, and the number of grating point centres occupied by inclusions is counted.

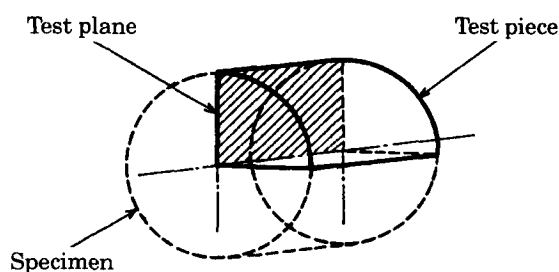
**4 Specimen and test piece** A specimen and a test piece shall be as follows:

**4.1 Specimen** A specimen shall be cut off from rolled or forged steel at right angles to the rolled direction or forged axis in a length sufficient for sampling the test piece.

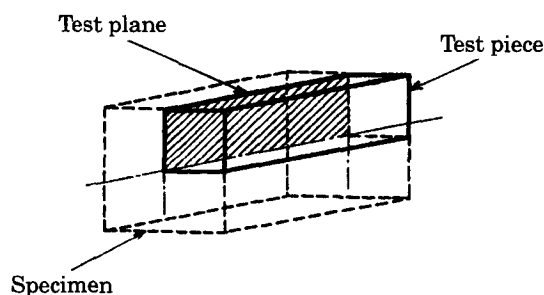
**4.2 Test piece** A test piece shall be as follows:

- a) The test piece shall be sampled by cutting out of the specimen parallel to its rolled direction or forged axis through the centre line of the specimen.
- b) The test piece shall have the test plane of, as a rule, 300 mm<sup>2</sup> extending from the surface to the centre line of the specimen.

Annex 1 figure 1 and annex 1 figure 2 show the sampling of the test pieces from round and square specimens, respectively.



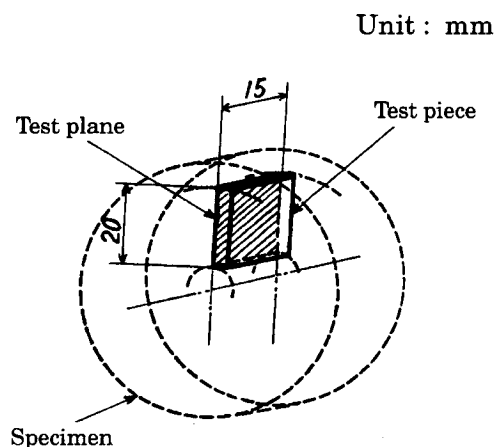
**Annex 1 Figure 1** Sampling of test piece from round specimen



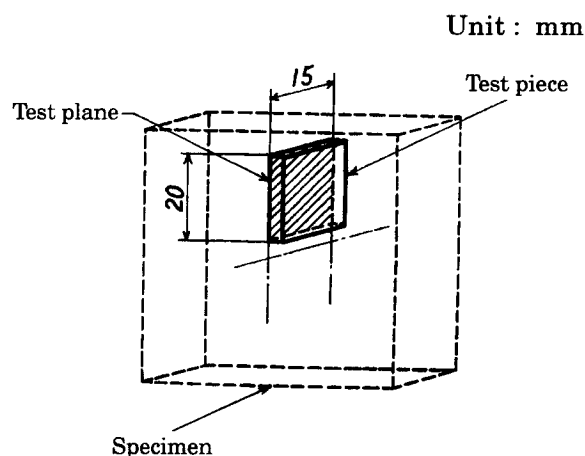
**Annex 1 Figure 2** Sampling of test piece from square specimen

- c) For the specimen of 60 mm or larger in thickness, width, diameter, side or width across flats, it is permitted to take the test piece from the intermediate portion between the surface and the centre axis of the specimen, parallel to the rolled direction or forged axis. In this case, the test plane shall, as a rule, be 15 mm wide and 20 mm high.

Annex 1 figure 3 and annex 1 figure 4 show the sampling of test piece from round and square specimens, respectively.



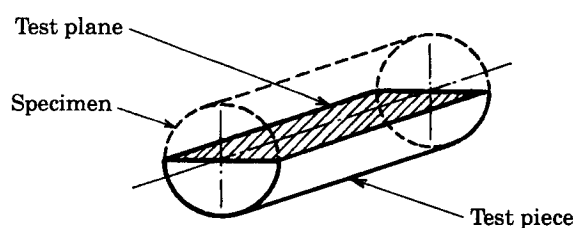
**Annex 1 Figure 3 Sampling of test piece from round specimen of diameter 60 mm or more**



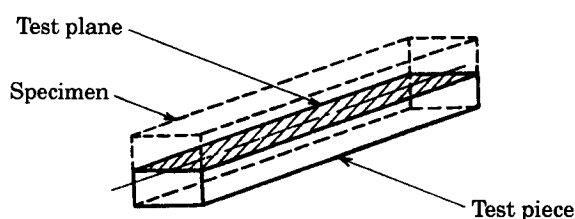
**Annex 1 Figure 4 Sampling of test piece from square specimen with thickness, width, side or width across flats of 60 mm or more**

- d) For the specimen of 20 mm or smaller in thickness, width, diameter, side or width across flats, the test plane may be taken along the cross-section passing through the centre line. In this case, the area of the test plane shall be determined.

Annex 1 figure 5 and annex 1 figure 6 show the sampling of the test piece from the round and the square specimens, respectively.



**Annex 1 Figure 5 Sampling of test piece from round specimen of diameter 20 mm or smaller**



**Annex Figure 6 Sampling of test piece from square specimen of a thickness, width, side or across flats of 20 mm or smaller**

- e) For the specimens of steel plate, steel pipe or steel section, the appropriate sampling method of the test piece shall be as agreed between the manufacturer and the purchaser.
- f) The sampling position and the area of test plane of the test piece shall be attached to the test result.

- g) The test plane shall be finished by polishing with emery paper or a buffer after the test piece is hardened or the test plane is hardened by carburizing. In this case, sufficient care shall be taken not to cause the falling out or concealing of inclusions, generation of pit and scratch, occurrence of rust and the like by coarse polishing.

**4.3 Classification of inclusions** Inclusions are classified into the following three types:

- a) **A type inclusion** Inclusions formed by viscous deformation during working (sulfides, silicates and the like). If necessary, they are classified further into sulfides and silicates, and the former shall be called A<sub>1</sub> type inclusion and the latter, A<sub>2</sub> type inclusion.
- b) **B type inclusion** Inclusions formed by granular inclusions discontinuously and collectively disposed in the working direction (alumina and the like).

As for the steel containing Nb, Ti, Zr (only one, or more thereof), if necessary, inclusions are further classified into oxide such as alumina and carbonitride of Nb, Ti and Zr, and the former shall be called B<sub>1</sub> type inclusion and the latter, B<sub>2</sub> type inclusion.

- c) **C type inclusion** Inclusions formed by irregular dispersion without viscous deformation (granular oxide and the like). As for the steel containing Nb, Ti and Zr (only one or more thereof), if necessary, inclusions further classified into oxide and carbonitride of Nb, Ti and Zr, and the former shall be called C<sub>1</sub> type inclusion and the latter, C<sub>2</sub> type inclusion.

**4.4 Test** A test shall be as follows:

- a) The glass plate having 20 grating lines, both in the longitudinal and lateral direction, shall be inserted in the eyepiece of the microscope, and the test plane shall be observed repeatedly at random. The number of grating points occupied by the inclusions shall be counted.
- b) The number of visual fields shall, as a rule, be 60 and shall be at least 30 or more.
- c) The magnification of microscope shall, as a rule, be 400.

**4.5 Judgement** By the total number of grating points found on the glass plate within the visual field, the number of visual fields and the number of grating points occupied by inclusions shall be calculated from the following formula and the index of cleanliness of the steel  $d$  (%) shall be judged.

$$d = \frac{n}{p \times f} \times 100$$

where,  $p$  : total number of grating points on the glass plate in the visual field

$f$  : the number of visual fields

$n$  : the number of grating points occupied by total inclusions through the visual fields numbering  $f$

**4.6 Marking** The results of judgement shall be marked as given below.

Example 1  $d60 \times 400 = 0.34 \% \dots\dots$   $\left( \begin{array}{l} \text{in the case of 60 in the number of observed} \\ \text{visual fields, 400 magnifications and 0.34 \%} \\ \text{in the index of cleanliness} \end{array} \right)$

Example 2  $dA60 \times 400 = 0.15 \%$   
 $dB60 \times 400 = 0.02 \% \dots$   
 $dC60 \times 400 = 0.09 \%$   $\left( \begin{array}{l} \text{in the case of 60 in the number of observed} \\ \text{visual fields, 400 magnifications and the index} \\ \text{of cleanliness of A, B and C type inclusions} \\ \text{are 0.15 \%, 0.02 \% and 0.09 \% respectively} \end{array} \right)$

**4.7 Report** In the case where a test report is required, the following items are selected as report items subject to the agreement between the manufacturer and the purchaser.

- a) Reference to this Standard
- b) The type or symbol of material and the melt number
- c) The sampling position and the test plane of a test piece
- d) Test results
- e) The number and date of the report

**Annex 2 (informative)**  
**Comparison table between JIS and corresponding International Standard**

| <b>JIS G 0555 : 2003</b> <i>Microscopic testing method for the non-metallic inclusions in steel</i> |                                                                                                                                                                                                                                                                                          | <b>ISO 4967 : 1998</b> <i>Steel—Determination of content of nonmetallic inclusions—Micrographic method using standard diagrams</i>                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (I) Requirements in <b>JIS</b>                                                                      |                                                                                                                                                                                                                                                                                          | (IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause<br>Location of deviation: text, annex<br>Indication method: dotted underlines or continuous sidelines |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Clause                                                                                              | Content                                                                                                                                                                                                                                                                                  | Content                                                                                                                                                                                                                  | (V) Justification for the technical deviation and future measures between <b>JIS</b> and the International Standard                                                                                                                                                                                                                                                                                                                                                    |
|                                                                                                     | Clause                                                                                                                                                                                                                                                                                   | Clause                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1 Scope                                                                                             | <ul style="list-style-type: none"> <li>• Rolled or forged steel product by a reduction ratio of 3 ≥.</li> <li>• Measurement by image processing technique is specified in annex D.</li> <li>• Measurement of an inclusion by a point counting method is specified in annex 1.</li> </ul> | 1<br>Scope<br>Ditto as in <b>JIS</b> .<br>However, measurement by a point counting method is not contained.                                                                                                              | <ul style="list-style-type: none"> <li>• The point counting method is mentioned in annex 1.</li> </ul> <p>The point counting method being the method for measuring the cleanliness in <b>JIS G 0555 : 1998</b> is quoted in annex. The point counting method is a measuring method which is excellent in quantitative property in comparison to a standard projection, and an enlargement of the scope is proposed (standardization of informative in <b>JIS</b>).</p> |
| 2 Principle                                                                                         | <ul style="list-style-type: none"> <li>• Inclusion types and morphologies and inclusion measuring principle are mentioned.</li> </ul>                                                                                                                                                    | 2<br>Principle<br>Ditto as in <b>JIS</b> .<br>except methods mentioned in tables 1 and 2.                                                                                                                                | <ul style="list-style-type: none"> <li>• No difference technically.<br/>In table 1, the range is mentioned without mentioning the minimum value corresponding to the rating.</li> <li>• Remarks of tables 1 and 2 are added.</li> </ul> <p>In the case of rating in tables 1 and 2, mentioned contents are changed in order to be easily understood.</p>                                                                                                               |

| (I) Requirements in <b>JIS</b>               |                                                                                                     | (III) Requirements in International Standard |                                                                              | (IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause |                               | (V) Justification for the technical deviation and future measures between <b>JIS</b> and the International Standard |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Clause                                       | Content                                                                                             | Clause                                       | Content                                                                      | Classification by clause                                                                                           | Detail of technical deviation |                                                                                                                     |
| 3 Sampling                                   | • Sampling position, direction and area of test piece                                               | 3                                            | Sampling<br>Ditto as in <b>JIS</b> .                                         | IDT                                                                                                                | —                             |                                                                                                                     |
| 4 Preparation of test piece                  | • A state of tested plane of test piece                                                             | 4                                            | Preparation of test piece<br>Ditto as in <b>JIS</b> .                        | IDT                                                                                                                | —                             |                                                                                                                     |
| 5 Determination of the content of inclusions |                                                                                                     | 5                                            | Measurement of inclusion                                                     |                                                                                                                    |                               |                                                                                                                     |
| 5.1 Method of observation                    | • Forming of a visual field to be evaluated and its area                                            | 5.1                                          | Observation method<br>Ditto as in <b>JIS</b> .                               | IDT                                                                                                                | —                             |                                                                                                                     |
| 5.2 Actual examination                       |                                                                                                     | 5.2                                          | Actual test<br>Ditto as in <b>JIS</b> .                                      | IDT                                                                                                                | —                             |                                                                                                                     |
| 5.2.1 Method A                               | • Measurement of the worst field examined                                                           | 5.2.1                                        | Test method A<br>Ditto as in <b>JIS</b> .                                    | IDT                                                                                                                | —                             |                                                                                                                     |
| 5.2.2 Method B                               | • Measurement of entire polished surfaces                                                           | 5.2.2                                        | Test method B<br>Ditto as in <b>JIS</b> .                                    | IDT                                                                                                                | —                             |                                                                                                                     |
| 5.2.3 General rules for methods A and B      | Classification of a series and specification of oversize. An inclusion considered as one inclusion. | 5.2.3                                        | Common specification in the test methods A and B<br>Ditto as in <b>JIS</b> . | IDT                                                                                                                | —                             |                                                                                                                     |
| 6 Expression of results                      |                                                                                                     | 6                                            | Expression of results                                                        |                                                                                                                    |                               |                                                                                                                     |

| (I) Requirements in JIS |                                                                                                                                          | (III) Requirements in International Standard |                                                                              | (IV) Classification and details of technical deviation between JIS and the International Standard by clause |                               | (V) Justification for the technical deviation and future measures between JIS and the International Standard |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------|
| Clause                  | Content                                                                                                                                  | Clause                                       | Content                                                                      | Classification by clause                                                                                    | Detail of technical deviation |                                                                                                              |
| 6.1 General             | • Expression method for results                                                                                                          | 6.1                                          | General<br>Ditto as in JIS.                                                  | IDT                                                                                                         | —                             |                                                                                                              |
| 6.2 Method A            | • Expression method for method A                                                                                                         | 6.2                                          | Test method A<br>Ditto as in JIS.                                            | IDT                                                                                                         | —                             |                                                                                                              |
| 6.3 Method B            | Method B, total index, average index and presentation method                                                                             | 6.3                                          | Test method B<br>Ditto as in JIS.                                            | IDT                                                                                                         | —                             |                                                                                                              |
| 7 Test report           | • Contents recorded in report<br>• As described in JIS G 0555                                                                            | 7                                            | Test report<br>As described in ISO 4967.                                     | IDT                                                                                                         | —                             |                                                                                                              |
| Annex A                 | JIS chart diagrams for inclusion groups A, B, C, D and DS<br>• Chart diagram for each group                                              | Annex A                                      | The chart diagram for inclusion groups A, B, C, D and DS<br>Ditto as in JIS. | IDT                                                                                                         | —                             |                                                                                                              |
| Annex B                 | Assessment of a field and of oversized inclusions<br>• Example of assessment of a field<br>Example of assessment of oversized inclusions | Annex B                                      | Assessment of a field and of oversized inclusions<br>Ditto as in JIS.        | IDT                                                                                                         | —                             |                                                                                                              |

| (I) Requirements in <b>JIS</b> |                                                                                                                                                                                                                                                                                                                                                                                                                         | (III) Requirements in International Standard |                                                                                                                 | (IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause<br>Location of deviation: text, annex<br>Indication method: dotted underlines or continuous sidelines |                                                       | (V) Justification for the technical deviation and future measures between <b>JIS</b> and the International Standard                                                                                                                                                                                        |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Clause                         | Content                                                                                                                                                                                                                                                                                                                                                                                                                 | Clause                                       | Content                                                                                                         | Classification by clause                                                                                                                                                                                                 | Detail of technical deviation                         |                                                                                                                                                                                                                                                                                                            |
| Annex C                        | <p>Typical example of results</p> <p>C.1 Indices according to field and type of inclusions</p> <p>C.2 Total number of fields per type of inclusion</p> <p>C.3 Calculation of total index and mean index</p> <p>C.3.1 For type A inclusions</p> <p>C.3.2 For type B inclusions</p> <p>C.3.3 For type C inclusions</p> <p>C.3.4 For type D inclusions</p> <p>C.3.5 For type DS inclusions</p> <p>C.4 Weighting factor</p> | Annex C                                      | <p>Typical examples of results</p> <p>Ditto as in <b>JIS</b>.</p>                                               | MOD/alteration                                                                                                                                                                                                           | Correction following errors in contents of <b>ISO</b> | <p>C.3.4 In presentation of group D, though oversize 1 s marking is attached, it is not required.</p> <p>C.4 Though cleanliness index is calculated from 0.5 to 3.5 in index, a weighting factor corresponding to 3.5 is not indicated in International Standard and the coefficient 3.0 is the limit.</p> |
| Annex D                        | <p>The relationships between the chart diagram indices and the inclusion measurements</p> <p>D.1 Calculation of chart diagram indices from measurements</p> <p>D.2 Calculation of the inclusion measurement from the index</p>                                                                                                                                                                                          | Annex D                                      | <p>Relation between the chart diagram indices and the inclusion measurements</p> <p>Ditto as in <b>JIS</b>.</p> | IDT                                                                                                                                                                                                                      | —                                                     |                                                                                                                                                                                                                                                                                                            |

| (I) Requirements in <b>JIS</b> |                                                                                                                                                                                                                                                                                                       | (III) Requirements in International Standard |         | (IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause<br>Location of deviation: text, annex<br>Indication method: dotted underlines or continuous sidelines |                                                                                                              | (V) Justification for the technical deviation and future measures between <b>JIS</b> and the International Standard                                                                                                      |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Clause                         | Content                                                                                                                                                                                                                                                                                               | Clause                                       | Content | Classification by clause                                                                                                                                                                                                 | Detail of technical deviation                                                                                |                                                                                                                                                                                                                          |
| Annex 1                        | Microscopic testing method for non-metallic inclusions by point counting method<br>1 Principle<br>2 Normative reference<br>3 Definitions<br>4 Specimen and test piece<br>4.1 Specimen<br>4.2 Test piece<br>4.3 Classification of inclusions<br>4.4 Test<br>4.5 Judgement<br>4.6 Marking<br>4.7 Report | —                                            | —       | MOD/<br>addition                                                                                                                                                                                                         | A point counting method being the method for measuring cleanliness in <b>JIS G 0555 : 1998</b> is specified. | The point counting method is a measuring method which is excellent in determination of quality in comparison to standard projection, and enlargement of the scope is proposed ( <b>JIS</b> informative is standardized). |

Designated degree of correspondence between **JIS** and International Standard: MOD

Remarks 1 Symbols in sub-columns of classification by clause in the above table indicate as follows:

— IDT: Identical in technical contents.

— MOD/addition: Adds specification item(s) or content(s) not included in International Standard.

— MOD/alteration: Alters the specification content(s) included in International Standard.

2 Symbol in column of designated degree of correspondence between **JIS** and International Standard in the above table indicates as follows:

— MOD: Modifies International Standard.

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