SMS

Powders for thermal spraying

Composition and technical delivery conditions
English version of DIN EN 1274

DIN EN 1274

ICS 25.220.20; 77.160

Supersedes DIN 32 529, October 1983 edition.

Descriptors: Powders, thermal spraying.

Thermisches Spritzen; Pulver; Zusammensetzung, technische Lieferbedingungen

European Standard EN 1274:1996 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by CEN/TC 240.

The responsible German body involved in its preparation was the *Normenausschuß Schweißtechnik* (Welding Standards Committee), Technical Committee *Thermisches Spritzen und thermisch gespritzte Schichten*.

The DIN Standards corresponding to the International Standards referred to in clause 2 of the EN are as follows:

ISO Standard	DIN Standard
ISO 3310-1	DIN ISO 3310-1
ISO 3923-2	DIN ISO 3923-2
ISO 3954	DIN ISO 3954
ISO 4490	DIN ISO 4490

Amendments

DIN 32 529, October 1983 edition, has been superseded by the specifications of EN 1274.

Previous editions

DIN 32 529: 1983-10; DIN 32 529-1: 1976-02.

EN comprises 24 pages.

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1274

June 1996

ICS 25.220.20; 77.160

Descriptors: Powders, thermal spraying.

English version

Thermal spraying

Powders,
Composition and technical delivery conditions

Projection thermique; poudres; composition et conditions techniques de livraison

Thermisches Spritzen; Pulver; Zusammensetzung und technische Lieferbedingungen

This European Standard was approved by CEN on 1996-02-10.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 1274:1996 E

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 240 'Thermal spraying', the Secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by December 1996 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard:

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

0 Introduction

The aim of this standard is to designate the most common powders for thermal spray-coating on the basis of their composition and degree of purity, enabling the greater part of the commercially available powders to be characterized and specified in accordance with this standard.

The standard is meant to give an overview of the variety of powders available on the market.

Given the large number of powders dealt with here, some abbreviations associated with thermal spraying have been used.

This standard does not cover properties of sprayed coatings, such as gas composition, deposition efficiency, material flow rate, or standoff distance, which may differ greatly from those of the original material.

The application of powders for thermal spraying has been elaborated on in the relevant literature and is therefore not dealt with in this standard.

1 Scope

This Standard covers powders, which are currently applicable in thermal spraying on the basis of the physical and chemical properties.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revision of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ISO 3310-1:1990 Test sieves - Technical requirements and testing - Part 1: Test sieves of metal wire cloth

ISO 3923-2:1981 Metallic powders - Determination of apparent density - Part 2: Scott volumeter method

ISO 3954:1977 Powders for powder metallurgical purposes - Sampling

ISO 4490:1978 Metallic powders - Determination of flowability by means of a calibrated funnel (Hall flowmeter)

3 Properties and property determination of powders for thermal spraying

3.1 Sampling and sample splitting

Sampling and sample splitting is to be done from a homogeneous mixture uniform in grain size. Directions for adequate methods and equipment are included in ISO 3954.

3.2 Chemical composition

The chemical composition shall be defined by any suitable testing method, e.g. atomic absorption spectrometry, flame emission spectroscopy, X-ray fluorescent analysis, etc.

3.3 Particle size range

Typical particle size ranges cover powder units preferably applied in thermal spraying.

When determined the particle size distribution by particle size measurement (see ISO 3310-1) the given upper limits may be exceeded by 2 mass % max. up to the next but one standard screen size, and the particle sizes fell below the lower limits by 5 mass % max.

Furthermore attention is drawn to the fact, that the resulted particle size depends on the measurement technique even for the same powder. The maximum permissible tolerances for upper und lower particle size range depends on the measuring method.

Measuring method, particle size range and max. permissible tolerances for upper und lower particle size range should be agreed upon between powder manufacturer and applier - if necessary in order to get the reproduceability of the thermal spraying process.

Powder will be supplied to suit the application and thermal spray process.

Examples of typical particle size ranges
µm

22/5
45/22
90/45
45/5
63/16
106/32

3.4 Particle size distribution

For a precise indication of particle size ranges it is necessary to measure the particle sizes and their distribution. If possible, X-ray absorption and laser beam scattering methods should be preferably used because of their significantly higher reproducibility, rapidity, and resolution of the measuring method compared with screening methods.

It shall be considered that the results of particle size measurement and particle distribution are dependent on the methods employed, and in the case of agglomerated powders, additionally are determined by the solubility of the used binder. Therefore, it is necessary to verify the suitability of the powder to be analysed for the selected test method. A powder test certificate shall contain the test method applied in addition to the particle size distribution.

3.5 Process of manufacture - particle shape

The manufacturing process of a powder shall be indicated using a term such as, for instance, fused, bonded, agglomerated, atomised etc. The shape of particles and their surface can be illustrated by means of scanning electron or stereo microscopy. In order to check for similarity the images may be compared to reference samples provided by the manufacturer.

Example illustrations are included in Annex A.

3.6 Apparent density

Apparent powder density is to be determined as specified in ISO 3923-2, and to be expressed as g/cm^3.

3.7 Flow properties, flowability

Powder flowability is to be determined as specified in ISO 4490, and expressed as s/50 g.

3.8 Microstructure

The microstructure of a powder particle can be represented in a metallographically prepared cross-section. The preparation method may be of decisive importance, and should, therefore, be agreed upon between manufacturer and user.

3.9 Determination of phases

Determination of phases as regards type, quantity, shape, configuration, composition and size, in polyphase powders can be made by, e.g. X-ray microstructure analysis, microprobe, metallographic or quantitative image analysis.

3.10 Summary

A survey of the significance of spray powder properties depending on the spraying process and the material category is included in table 1.

4 Classification of powders

The powders for thermal spraying are categorised on the basis of their chemical composition into

- pure metals,
- metallic alloys and composits,
- carbides, carbides with metals, carbides with metallic alloys and composites,
- oxides, phospates and other non-carbide ceramics,
- organic materials.

Blended powders of several varying components are not itemised because of their innumerable number.

Table 1. The significance of spray powder properties depending on the spraying process and the material category

		Chemical composition	Particle size	Particle shape	Apparent density	Flowability	Micro-structure	Phase composition	Melting range
3.10.1	Pure metals	+++	+++	++	+	+	-	-	-
	Metallic alloys	+++	+++	++	+	+	-	+	++ 3)
	Carbides, carbides with metals, carbides with metallic alloys	+++	+++	++	+	+	++	++	-
	Oxides, phosphats and other non-carbide ceramics	+++	+++	++	+	+	+	+	-
	Organic materials	+++	+++	+	+	++	-	-	+++ 1)
3.10.2	Plasma spraying	++	+++	++	-	+	-	++ 2)	-
	Flame spraying	++	+++	+	-	+++	-	-	+++ 3)
	High velocity flame spraying	++	+++	+++	++	+	-	++ 2)	+

+++ Specification imperative/critical property
++ Specification recommended/important property
\+ Supplementary detail
\- without significance

1) In organic material spraying, decomposition temperature and oxidation resistance of the molten material, as wil as toxicological characteristics are additional criteria.

2) Necessary detail for the spraying of carbides and oxides (e.g. ZrO_2-Y_2O_3).

3) For SF - alloys.

4.1 Pure metals

Tabelle 2

Code No.	Main constituent	Chemical composition in % O max.	C max.	N max.	H max.	Al max.	Co max.
1.1	Ti 99	0,3	0,3	0,3	0,1	-	-
1.2	Nb 99	0,3	0,3	0,3	0,1	-	-
1.3	Ta 99	0,3	0,3	0,3	0,1	-	-
1.4	Cr 98,5	0,8	0,1	0,1	-	0,5	-
1.5	Mo 99	0,3	0,15	0,1	-	-	-
1.6	W 99	0,3	0,15	0,1	-	-	0,3
1.7	Ni 99,3	0,5	0,1	0,1	-	-	-
1.8	Cu 99	-	-	-	-	-	-
1.9	Al 99	0,5	-	-	-	-	-
1.10	Si 99	-	-	-	-	-	-

4.2 Metallic alloys and composites

4.2.1 Self-fluxing alloys

Table 3

Code No.	Symbols	Chemical Composition in %									
		C	Ni	Co	Cr	Cu	W	Mo	Fe	B	Si	Others
2.1	NiCuBSi 76 20	max. 0,05	Rem	-	-	19 to 20	-	-	max. 0,5	0,9 to 1,3	1,8 to 2,0	max. 0,5
2.2	NiBSi 96	max. 0,05	Rem	-	-	-	-	-	max. 0,5	1,0 to 1,5	2,0 to 2,5	max. 0,5
2.3	NiBSi 94	max. 0,1	Rem	-	-	-	-	-	max. 0,5	1,5 to 2,0	2,8 to 3,7	max. 0,5
2.4	NiBSi 95	0,1 to 0,2	Rem	-	-	-	-	-	max. 2,0	1,2 to 1,7	2,2 to 2,8	max. 0,5
2.5	NiCrBSi 90 4	0,1 to 0,2	Rem	-	3 to 5	-	-	-	max. 1,0	1,4 to 1,8	2,8 to 3,5	max. 0,5
2.6	NiCrBSi 86 5	0,15 to 0,25	Rem	-	4 to 6	-	-	-	3,0 to 3,5	0,8 to 1,2	2,8 to 3,2	max. 0,5
2.7	NiCrBSi 88 5	0,15 to 0,25	Rem	-	4 to 6	-	-	-	1,0 to 2,0	1,0 to 1,5	3,5 to 4,0	max. 0,5
2.8	NiCrBSi 83 10	0,15 to 0,25	Rem	-	8 to 12	-	-	-	1,5 to 3,5	2,0 to 2,5	2,3 to 2,8	max. 0,5
2.9	NiCrBSi 85 8	0,15 to 0,25	Rem	-	6 to 10	-	-	-	1,5 to 2,0	1,5 to 2,0	2,6 to 3,4	max. 0,5
2.10	NiCrBSi 84 8	0,25 to 0,4	Rem	-	7 to 10	-	-	-	1,7 to 2,5	1,5 to 2,2	3,2 to 4,0	max. 0,5
2.11	NiCrBSi 88 4	0,3 to 0,4	Rem	-	3,5 to 4,5	-	-	-	max. 2	1,6 to 2,0	3,0 to 3,5	max. 0,5
2.12	NiCrBSi 80 11	0,35 to 0,6	Rem	-	10 to 12	-	-	-	2,5 to 3,5	2,0 to 2,5	3,5 to 4,0	max. 0,5
2.13	NiCrWBSi 64 11 16	0,5 to 0,6	Rem	-	10 to 12	-	15,5 to 16,5	-	3,5 to 4,0	2,3 to 2,7	3,0 to 3,5	max. 0,5
2.14	NiCrCuMoBSi 67 17 3 3	0,5 to 0,7	Rem	-	16 to 17	2,0 to 3,5	-	2,0 to 3,0	2,5 to 3,5	3,4 to 4,0	4,0 to 4,5	max. 0,5
2.15	NiCrCuMoWBSi 64 17 3 3 3	0,4 to 0,6	Rem	-	16 to 17	2,0 to 3,5	2,0 to 3,0	2,0 to 3,0	3,0 to 5,0	3,5 to 4,0	4,0 to 4,5	max. 0,5
2.16	NiCrBSi 74 15	0,75 to 1,0	Rem	-	16 to 17	-	-	-	3,5 to 5,0	2,8 to 3,5	3,6 to 4,5	max. 0,5

(continued)

Table 3 (concluded)

Code Nr.	Symbols	Chemical Composition in % C	Ni	Co	Cr	Cu	W	Mo	Fe	B	Si	Others
2.17	NiCrBSi 65 25	0,8 to 1,0	Rem	-	24 to 26	-	-	-	0,2 to 1,0	3,2 to 3,6	4,0 to 4,5	max 0,5
2.18	NiCrBSi 74 14	max. 0,05	Rem	-	13 to 15	-	-	-	4,0 to 5,0	2,75 to 3,5	4,0 to 5,0	max. 0,5
2.19	NiCrBSi 82 7	max. 0,06	Rem	-	6,5 to 8,5	-	-	-	2,5 to 3,5	2,5 to 3,5	4,1 to 4,6	max. 0,5
2.20	NiBSi 92	max. 0,06	Rem	-	-	-	-	-	max. 0,5	2,75 to 3,5	4,3 to 4,7	max 0,5
2.21	NiCoBSi 71 20	max. 0,05	Rem	20	-	-	-	-	max. 0,5	2,7 to 3,2	4,0 to 5,0	max. 0,5
2.22	CoCrNiMoBSi 40 18 27 5	max. 0,1	26 to 28	Rem	18 to 19	-	-	4,0 to 6,0	max. 2,0	3,0 to 3,4	3,0 to 3,5	max. 0,5
2.23	CoCrNiMoBSi 50 18 17 6	0,1 to 0,3	17 to 19	Rem	18 to 20	-	-	6,0 to 8,0	max. 2,5	3,0	3,5	max. 0,5
2.24	CoCrNiWBSi 53 20 13 7	0,75 to 1,0	13 to 16	Rem	19 to 20	-	6 to 8	-	max. 3,0	1,5 to 1,8	2,4 to 2,5	max. 0,5
2 25	CoCrNiWBSi 52 19 15 9	0,8 to 1,1	13 to 16	Rem	19 to 20	-	8 to 10	-	max. 3,0	1,5 to 1,8	2,4 to 2,5	max. 0,5
2.26	CoCrNiWBSi 47 19 15 13	1,0 to 1,3	13 to 16	Rem	19 to 20	-	12,5 to 13,5	-	max. 3,0	1,5 to 2,0	2,0 to 2,5	max. 0,5
2.27	CoCrNiWBSi 45 19 15 15	1,3 to 1,6	13 to 16	Rem	19 to 20	-	14,5 to 15,5	-	max. 3,0	2,8 to 3,0	2,7 to 3,5	max. 0,5

4.2.2 Nickel-chromium-iron-alloys

Table 4

Code No	Symbols	Chemical Composition in %													
		Ni	Cr	Al	W	Co	Mo	Cu	Fe	Si	Mn	Ti	Y	C max.	Others
3.1	NiCr 80 20	Rem	18 to 21	-	-	-	-	-	max. 1	max. 1,5	max. 2,5	-	-	0,25	-
3.2	NiCrFe 75 15 8	Rem	14 to 17	-	-	-	-	-	6 to 10	-	-	-	-	0,30	-
3.3	NiCrAl 74 19 5	Rem	17 to 20	3 to 6	-	-	-	-	max. 1	max. 1,5	max. 2,5	-	-	0,25	-
3.4	NiCrNb 70 21 4	Rem	20 to 22	0,3 to 0,5	-	-	-	-	2 to 3	0,4 to 0,6	0,4 to 0,6	0,3 to 0,5	-	0,10	3 to 4 Nb
3.5	NiCrMoW 54 16 17 5	Rem	14 to 18	-	4 to 6	-	16 to 18	-	max. 6	max. 1	max. 0,5	-	-	0,50	-
3.6	NiCrAlMoFe 73 9 7 6 5	Rem	8 to 10	6 to 88	-	-	4 to 6	-	4 to 6	-	-	-	-	-	-
3.7	NiCrTiAl 75 20 3 2	Rem	18 to 22	1,5 to 2,5	-	-	-	-	-	-	-	2 to 3	-	-	-
3.8	NiCrCoAlTi 67 16 9 4 4	Rem	15 to 17	3 to 4	2 to 3	8 to 9	1 to 3	-	0,4 to 0,6	max. 0,3	max. 0,2	3 to 4	-	0,20	-
3.9	NiCoCrAlMoTi 63 15 10 5 3 4	Rem	8 to 12	4 to 6	-	14 to 16	2 to 4	-	-	-	-	4 to 5	-	0,20	-
3.10	NiCoCrAlMoTi 57 17 11 5 6 4	Rem	10 to 12	4 to 5	-	15 to 18	5 to 7	-	max. 0,5	max. 0,2	-	3 to 5	-	0,03	-
3.11	NiCr 50 50	Rem	50 to 53	-	-	-	-	-	-	max. 2	max. 1	-	-	0,5	-
3.12	NiCrMoNb 64 22 9 3,5	Rem	20 to 23	-	-	-	8 to 10	-	1	0,25	-	-	-	0,01	3 to 4 Nb
3.13	NiCrCoMoTiAlW 57 18 12 6 3 2 1	Rem	17 to 19	1,5 to 2,5	1	11 to 13	5 to 7	-	-	-	-	2,5 to 3,5	-	-	-
3.14	NiCrNbFeAl 66 14 7 8 5,5	Rem	11,5to16	2,5 to 4,5	-	-	-	-	6 to 9,5	-	0,4 to 0,6	0,3 to 0,5	-	0,1	6,5to7,5Nb
3.15	NiCrFeAlMo 68 14 7 5 5	Rem	12 to 16	4 to 6	-	-	4 to 6	-	5 to 9	-	-	-	-	-	-
3.16	NiCrAlMoTiO$_2$ 68 8 7 5 2,5	Rem	7 to 10	5 to 9	-	-	3 to 7	-	1 to 3	2	-	-	-	-	2,5 TiO$_2$ 2 B
3.17	FeCrMoAl 65 23 5 5	0,5 max	20 to 25	4 to 6	-	-	3 to 7	-	Rem	1	-	-	-	0,1 to 0,5	-

4.2.3 MCrAlY - alloys

Table 5

Code No.	Symbols	Chemical Compositions in %													
		Ni	Cr	Al	W	Co	Mo	Cu	Fe	Si	Mn	Ti	Y	C max.	Others
4.1	NiCrAlY 66 22 10 1	Rem	21 to 23	9 to 11	-	-	-	-	-	-	-	-	0,8 to 1,2	-	-
4.2	NiCrAlY 70 23 6	Rem	22 to 24	5 to 7	-	-	-	-	-	-	-	-	0,3 to 0,5	-	-
4.3	NiCoCrAlY 46 23 17 13	Rem	15 to 19	11,5 to 13,5	-	20 to 26	-	-	-	-	-	-	0,2 to 0,7	-	-
4.4	NiCoCrAlY 47 22 17 13	Rem	15 to 19	11,5 to 13,5	-	20 to 24	-	-	-	-	-	-	0,4 to 0,8	-	-
4.5	NiCoCrAlYSiHf 47 22 17 13	Rem	15 to 19	11,8 to 13,2	-	20 to 24	-	-	-	0,2 to 0,6	-	-	0,4 to 0,8	-	0,1 to 0,4 Hf
4.6	CoCrAlY 63 23 13	-	22 to 24	12 to 14	-	Rem	-	-	-	-	-	-	0,55 to 0,75	-	-
4.7	CoNiCrAlY 38 32 21 8	31 to 33	20 to 22	7 to 9	-	Rem	-	-	-	-	-	-	0,35 to 0,65	-	-
4.8	CoCrNiAlYTa 52 25 10 7,5	8 to 12	23 to 27	5 to 9	-	Rem	-	-	-	-	-	-	0,4 to 0,8	-	4 to 6 Ta
4.9	FeCrAlY 74 20 5	-	18 to 22	3 to 7	-	-	-	-	Rem	-	-	-	0,3 to 0,7	0,02	-

4.2.4 Nickel-aluminium-iron alloys and composites

Table 6

Code No.	Symbols	Chemical composition in %													
		Ni	Cr	Al	W	Co	Mo	Cu	Fe max.	Si max.	Mn max.	Sn	P	C	Others
5.1	NiAl 95 5	Rem	-	3 to 6	-	-	-	-	1	0,5	-	-	-	-	-
5.2	NiAl 70 30	Rem	-	28 to 32	-	-	-	-	1	0,5	1	-	-	0,25	-
5.3	NiAl 80 20	Rem	-	18 to 22	-	-	-	-	1	0,5	1	-	-	0,25	-
5.4	NiAlMo 90 5 5	Rem	-	3 to 6	-	-	4 to 6	-	1	0,5	-	-	-	-	-
5.5	NiAlMo 89 10 1	Rem	-	8 to 12	-	-	0,5 to 1,5	-	1	0,5	-	-	-	-	-
5.6	FeNiAl 51 38 10	36 to 40	-	8 to 12	-	-	-	-	Rem	-	-	-	-	-	-
5.7	FeNiAlMo 54 35 5 5	33 to 37	-	3 to 6	-	-	3 to 7	-	Rem	-	-	-	-	-	-

4.2.5 High alloyed steels

Table 7

Code No.	Symbols	Chemical composition in % Ni	Cr	Mo	Fe	Si	Mn	P	S	C	Others
6.1	X42Cr13	-	11,5 to 13,5	-	Rem	0,3 to 0,5	0.2 to 0,4	≤ 0,03	≤ 0,03	0,38 to 0,45	-
6.2	X105CrMo17	-	16 to 18	0,4 to 0,8	Rem	≤ 1	≤ 1	≤ 0,045	≤ 0,03	0,95 to 1,20	-
6.3	X2CrNi 18 9	10 to 12,5	17 to 20	-	Rem	≤ 1	≤ 2	≤ 0,045	≤ 0,03	≤ 0,03	-
6.4	X5CrNi 18 9	8,5 to 10	17 to 20	-	Rem	≤ 1	≤ 2	≤ 0,045	≤ 0,03	≤ 0,07	-
6.5	X2CrNiMo 18 10	11 to 14	16,5 to 18,5	2 to 2,5	Rem	≤ 1	≤ 2	≤ 0,045	≤ 0,03	≤ 0,03	-
6.6	X2CrNiMo 18 12	12,5 to 15	16,5 to 18,5	2,5 to 3	Rem	≤ 1	≤ 2	≤ 0,045	≤ 0,03	≤ 0,03	-
6.7	X5CrNiMo 18 10	9,5 to 13,5	16,5 to 20,0	2 to 2,5	Rem	≤ 1	≤ 2	≤ 0,045	≤ 0,03	≤ 0,07	-
6.8	X5CrNiMo 18 12	11,5 to 14,0	16,5 to 18,5	2,5 to 3,0	Rem	≤ 1	≤ 2	≤ 0,045	≤ 0,03	≤ 0,07	-
6.9	X10CrNiMo 17 13	12 to 14	16 to 18	2 to 2,5	Rem	≤ 0,75	≤ 2	≤ 0,045	≤ 0,03	0,08 to 0,11	-
6.10	X2NiCrMoCu 25 20 5	24 to 26	19 to 21	4 to 5	Rem	≤ 1	≤ 2	≤ 0,03	≤ 0,02	≤ 0,02	-
6.11	X130CrMoWV 5 5 5 4	-	4 to 5	4 to 5	Rem	-	-	-	-	1,0 to 1,5	V 3,5 to 4,5 W 5 to 6

4.2.6 Cobalt-chromium alloys

Table 8

Code No.	Symbols	Chemical Composition in % Ni	Cr	Al	W	Co	Mo	Cu	Fe max.	Si	Mn max.	Sn	P max.	C	Others
7.1	CoCrW 50 30 12	max. 3	29 to 31	-	11,5 to 13,5	Rem	-	-	3	0,8 to 1,1	-	-	-	2,3 to 2,5	-
7.2	CoCrW 60 28 4	max. 3	27 to 30	-	3,5 to 5	Rem	-	-	3	0,8 to 1,1	-	-	-	0,9 to 1,2	-
7.3	CoCrW 53 30 8	max. 3	29 to 31	-	7,5 to 9	Rem	-	-	3	1,0 to 1.6	-	-	-	1,3 to 1,6	-
7.4	CoCrNiW 50 26 10 7	9,5 to 11,5	24 to 27	-	6,5 to 8,5	Rem	-	-	2	max. 0,6	0,6	-	-	max. 0,5	-
7.5	CoCrMo 60 27 5	max. 3	25 to 29	-	-	Rem	4,5 to 6,5	-	3	max. 2,5	1	-	-	max. 0,3	-
7.6	CoCrNiW 40 25 22 10	20 to 24	23 to 27	-	10 to 14	Rem	-	-	-	-	1	-	-	1,5 to 2,0	-
7.7	CoMoCrSi 51 28 17 3	max. 1,5	16 to 19	-	-	Rem	27 to 30	-	1,5	3 to 4	-	-	-	-	-
7.8	CoCrNiNb 50 28 7 6	5,5 to 7,5	26 to 30	-	-	Rem	2,5 to 4.5	1,4 to 1,8	2	max. 0,6	max. 0,6	-	-	1,8 to 2,2	Nb 4,5 to 6,5

4.2.7 Copper-aluminium alloys and composites, copper-tin- and copper-nickel alloys

Table 9

Code No.	Symbols	Chemical Composition in %													
		Ni	Cr	Al	W	Co	Mo	Cu	Fe max	Si	Mn	Sn	P max	C	Others
8.1	CuAl10	-	-	9 to 11	-	-	-	Rem	-	-	-	-	-	-	-
8.2	CuAl10Fe	-	-	9 to 11	-	-	-	Rem	1	-	-	-	-	-	-
8.3	CuAl10Ni	2 to 5	-	9 to 11	-	-	-	Rem	-	-	-	-	-	-	-
8.4	CuSn8	-	-	-	-	-	-	Rem	-	-	-	7,5 to 9	0,4	-	-
8.5	CuNi38	35 to 40	-	-	-	-	-	Rem	-	-	-	-	-	-	-
8.6	CuNi36In	35 to 38	-	-	-	-	-	Rem	1	-	-	-	-	-	4 to 6 In

4.2.8 Aluminium alloys

Table 10

Code No.	Symbols	Chemical Composition in %													
		Ni	Cr	Al	W	Co	Mo	Cu	Fe	Si	Mn	Sn	P max.	C	Others
9.1	AlSi 88 12	-	-	Rem	-	-	-	-	-	11 to 13	-	-	-		-

4.2.9 Nickel-graphite composites

Table 11

Code No.	Symbols	Chemical Composition in %						
		Al	Ni	Co max.	Ti	Cr	Mo	Graphite
10.4	Ni-Graphite 60/40	-	59 to 62	0,5	-	-	-	Rem
10.5	Ni-Graphite 75/25	-	74 to 76	0,5	-	-	-	Rem
10.6	Ni-Graphite 80/20	-	79 to 81	0,5	-	-	-	Rem
10.7	Ni-Graphite 85/15	-	84 to 86	0,5	-	-	-	Rem

4.3 Carbides, carbides with metals, carbides with metallic alloys and composites

Table 12

Code No.	Symbols	Chemical Composition in % W	Cr	Ti min.	Co	Ni	C	Fe max.	Si max.
11.1	TiC*)	-	-	79,5	-	-	19 to 20	-	-
11.2	WC*)	Rem	-	-	-	-	6,0 to 6,2	-	-
11.3	W_2C/WC*)	Rem	-	-	-	-	3,8 to 4,3	-	-
11.4	W_2C*)	Rem	-	-	-	-	3,1 to 3,3	-	-
11.5	Cr_3C_2*)	-	min. 86	-	-	-	min. 12,5	0,7	0,1
11.10	WC/Co 94 6	Rem	-	-	5 to 7	-	min. 5,2	-	-
11.11	WC/Co 88 12	Rem	-	-	11 to 13	-	3,6 to 4,2	-	-
11.12	WC/Co 88 12	Rem	-	-	11 to 13	-	4,8 to 5,5	-	-
11.13	WC/Co 83 17	Rem	-	-	16 to 18	-	min. 4,8	-	-
11.14	WC/Co 80 20	Rem	-	-	18 to 20	-	4,5 to 5,0	-	-
11.15	W_2C/Co	Rem	-	-	18 to 21	-	2,4 to 2,6	-	-
11.16	WC/Ni 92 8	Rem	-	-	-	6 to 8	3,5 to 4,0	-	-
11.17	WC/Ni 88 12	Rem	-	-	-	11 to 13	5,0 to 5,5	-	-
11.18	WC/Ni 85 15	Rem	-	-	-	14 to 16	3 to 4	-	-
11.19	WC/Ni 83 17	Rem	-	-	-	16 to 19	4,5 to 5,5	-	-
11.20	WC/Co/Cr 86 10 4	Rem	3,5 to 4,5	-	9 to 11	-	3,5 to 4,5	-	-
11.21	WCrC/Ni 93 7	Rem	22 to 28	-	-	6 to 8	5 to 7	-	-
11.30	Cr_3C_2/Ni 83 17	-	Rem	-	-	16 to 19	10 to 11	-	-
11.31	Cr_3C_2/NiCr 75 25	-	Rem	-	-	19 to 21	9 to 10	-	-
11.32	Cr_3C_2/NiCr80 20	-	Rem	-	-	14 to 18	9 to 11	-	-
*) These powders are used as a blend with other powders.									

4.4 Oxides, phosphates and non carbide ceramics

Table 13

Code No.	Symbols	Chemical composition in %								
		Al_2O_3	TiO_2	Cr_2O_3	ZrO_2	MgO/ CeO_2/ H-A	Y_2O_3	CaO	FeO max.	SiO_2
12.1	Al_2O_3	min. 99,5	-	-	-	-	-	-	0,1	max. 0,1
12.2	Al_2O_3-TiO_2 97 3	min. 96	2,5 to 3,5	-	-	-	-	-	1	max. 1
12.3	Al_2O_3-TiO_2 87 13	Rem	12 to 14	-	-	-	-	-	0,5	max. 1
12.4	Al_2O_3-TiO_2 60 40	Rem	37 to 42	-	-	-	-	-	-	-
12.5	Al_2O_3-MgO 70 30	Rem	-	-	-	MgO 28 to 31	-	-	0,5	max. 1,5
12.6	Al_2O_3-SiO_2 70 30	Rem	-	-	-	-	-	-	0,2	22 to 28
12.7	Al_2O_3-Cr_2O_3 98 2	min. 97,5	-	1,5 to 2,1	-	-	-	-	0,1	max. 0,3
12.8	Al_2O_3-Cr_2O_3 90 10	Rem	-	8 to 12	-	-	-	-	0,1	max. 0,2
12.9	Al_2O_3-Cr_2O_3 50 50	Rem	-	48 to 52	-	-	-	-	0,1	max. 0,2
12.20	Cr_2O_3	-	-	min. 99,5	-	-	-	-	0,1	max. 0,25
12.21	Cr_2O_3	max. 1,0	-	min. 96	-	-	-	-	1	max. 1
12.22	Cr_2O_3-TiO_2 97 3	-	max. 3	min. 96,5	-	-	-	-	0,5	-
12.23	Cr_2O_3-TiO_2 45 55	-	53 to 56	Rem	-	-	-	-	0,5	max. 0,5
12.24	Cr_2O_3-TiO_2 60 40	-	38 to 42	Rem	-	-	-	-	0,5	max. 0,5
12.25	Cr_2O_3-SiO_2-TiO_2 92 5 3	-	2 to 4	Rem	-	-	-	-	0,5	4 to 6
12.30	TiO_2	-	min. 99	-	-	-	-	-	0,5	max. 0,5

(continued)

Table 13 (concluded)

Code No.	Symbols	Chemical Composition in %								
		Al_2O_3	TiO_2	Cr_2O_3	ZrO_2	MgO/ CeO_2/ H-A	Y_2O_3	CaO	FeO max.	SiO_2
12.40	ZrO_2-CaO 95 5	max. 0,5	-	-	Rem	-	-	5 to 7	-	max. 0,4
12.41	ZrO_2-CaO 90 10	max. 0,5	-	-	Rem	-	-	8 to 10	-	max. 0,4
12.42	ZrO_2-CaO 70 30	max. 0,5	-	-	Rem	-	-	28 to 31	-	-
12.43	ZrO_2-MgO 80 20	-	-	-	Rem	MgO 18 to 24	-	1,5	-	max. 1,5
12.44	ZrO_2-Y_2O_3 93 7	max. 0,2	max. 0,3	-	Rem	-	6 to 8	-	0,2	max. 0,5
12.45	ZrO_2-Y_2O_3 80 20	-	-	-	Rem	-	18 to 21	-	0,2	max. 0,5
12.46	ZrO_2-SiO_2 65 35	-	max. 0,3	-	Rem	-	-	-	0,3	32 to 35
12.47	ZrO_2-CeO_2-Y_2O_3 68-25-3	-	-	-	Rem	CeO_2 24 to 26	2 to 4	-	0,2 to 0,5	0,5 to 1,5
12.60	Hydroxylapatite	-	-	-	-	H-A min. 95*)	-	-	-	-

*) Other impurities As max. 0,0003; Cd max. 0,0005; Hg max. 0,0005; Pb max. 0,003; total max. 0,1

4.5 Organic materials

A number of organic spray materials (synthetics) are presently undergoing spray testing. The most frequently used materials in these days are an ethylene-hydroethylene-copolymer and polyester in powder flame spraying.

5 Designation

The designation of a sintered tungsten-carbide-cobalt alloy spray powder containing 12 % Co and approximately 5 % C (Code No. 11.12), particle size range 45/5 µm is

spray powder EN 1274 - 11.12 -45/5- sintered.

6 Conditions of supply

Powders shall be dry and free from impurities.

Powders are to be delivered in airtigth and dampproof, sealed plastic or sheetmetal containers. Special packaging, e. g. vacuum containers with flange connection, is to be agreed upon with the powder manufacturer or supplier respectively.

The powder containers shall be labelled "Mix before using" and "For powder processing, the safety regulation sheet shall be observed".

7 Powder identification

The uniform identification of powders for thermal spraying should serve to designate a spray powder in a brief and welldefined (unmistakable) form.

8 Certification

The manufacturer/supplier has to certify that every batch of his products meets the requirements of the specification, documented by a test certificate accompanying the thermal spray powder.

This certificate, in addition to the results of chemical and physical analysis - as far as specified and/or agreed upon between customer und manufacturer/ supplier -, shall contain the product designation and batch-No.

Annex A
(informative)

Example illustration to demonstrate the relationship of the particle configuration and manufacturing process.

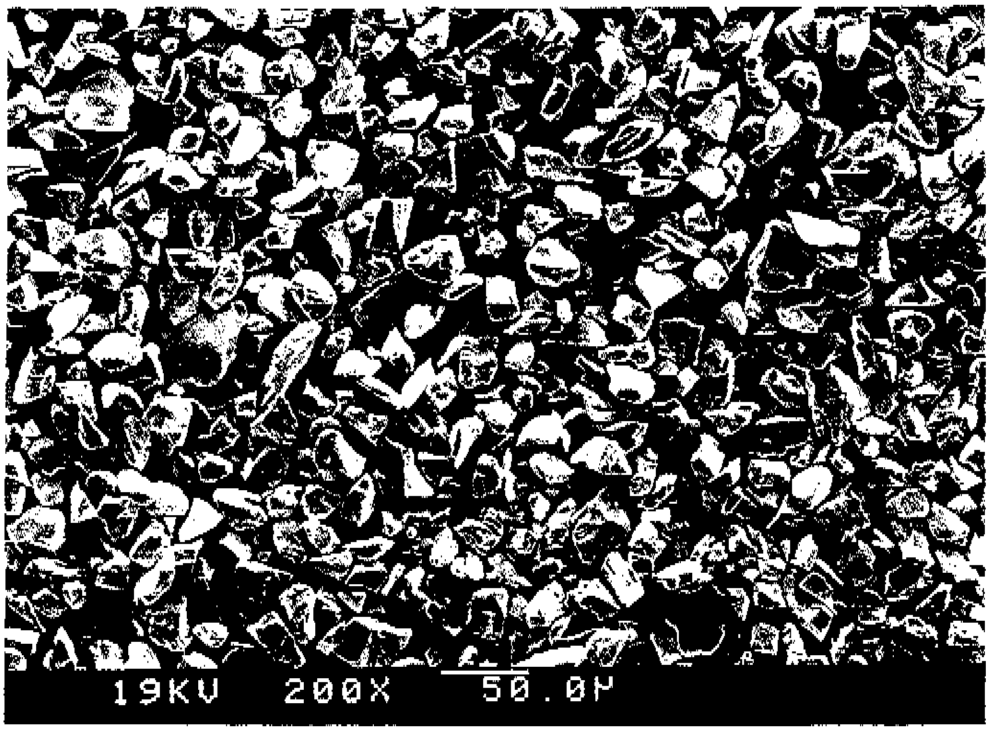

Figure A.1. Cr_2O_3 fused-crushed; particle shape: blocky

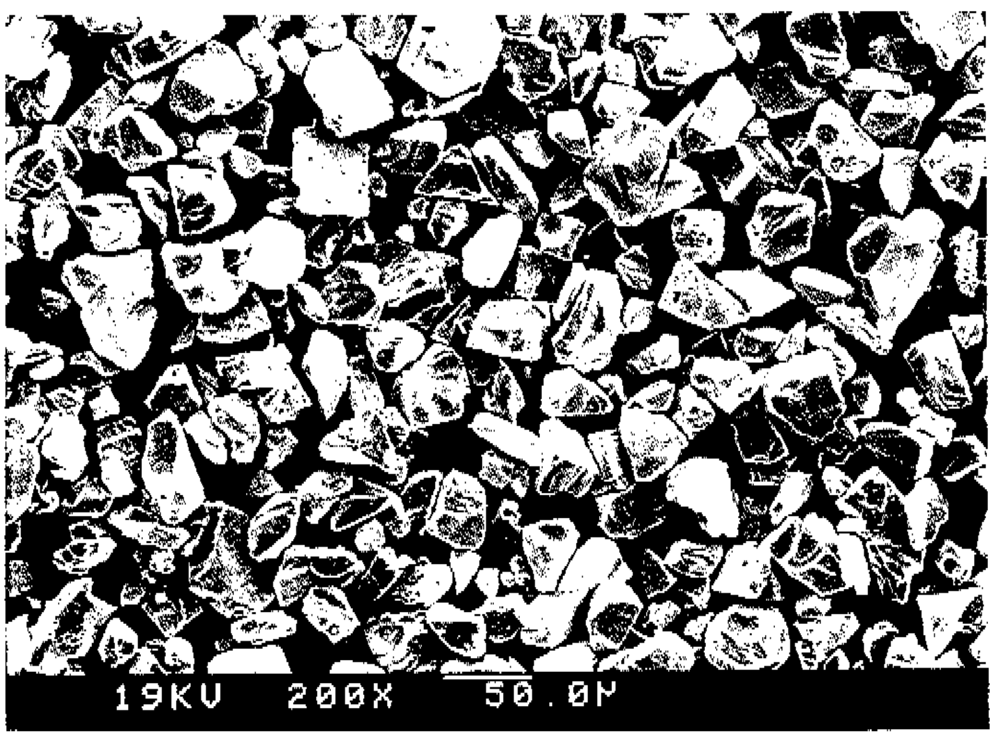

Figure A.2. Cr_2O_3 sintered-crushed; particle shape: blocky

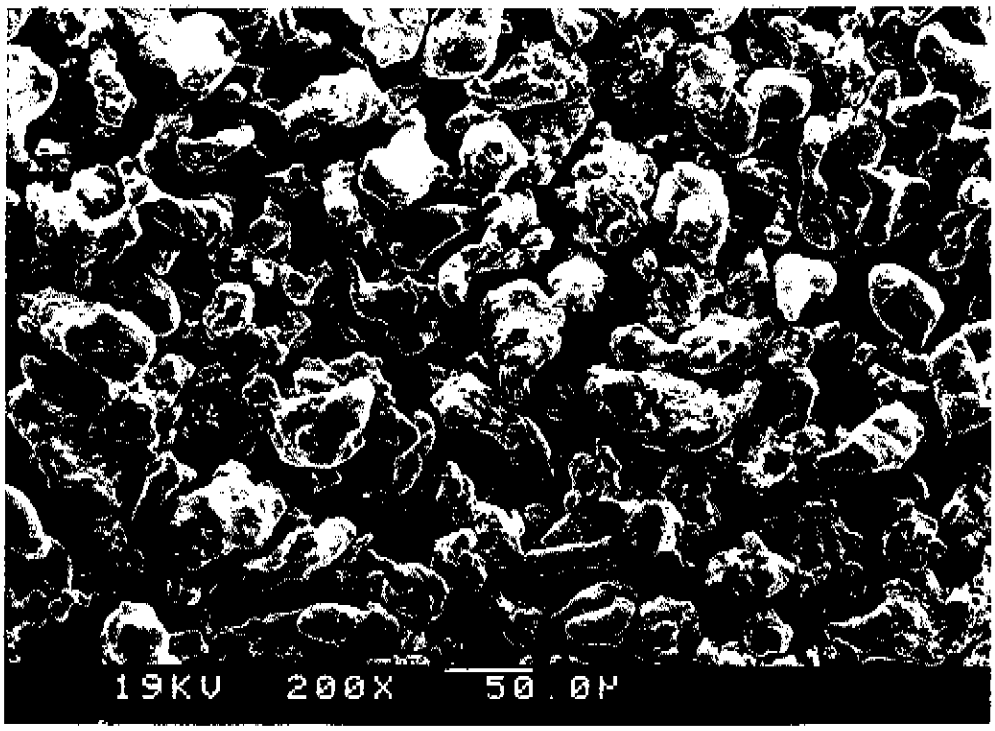

Figure A.3. NiAl water-atomised; particle shape: irregular

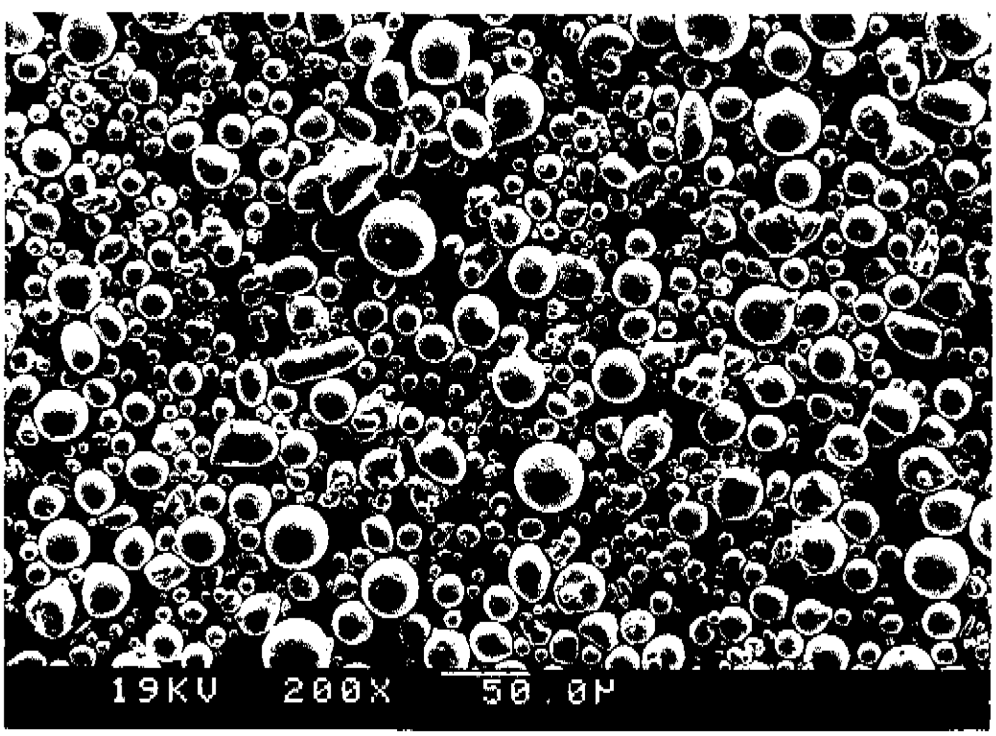

Figure A.4. NiAl gas-atomised; particle shape: spherical

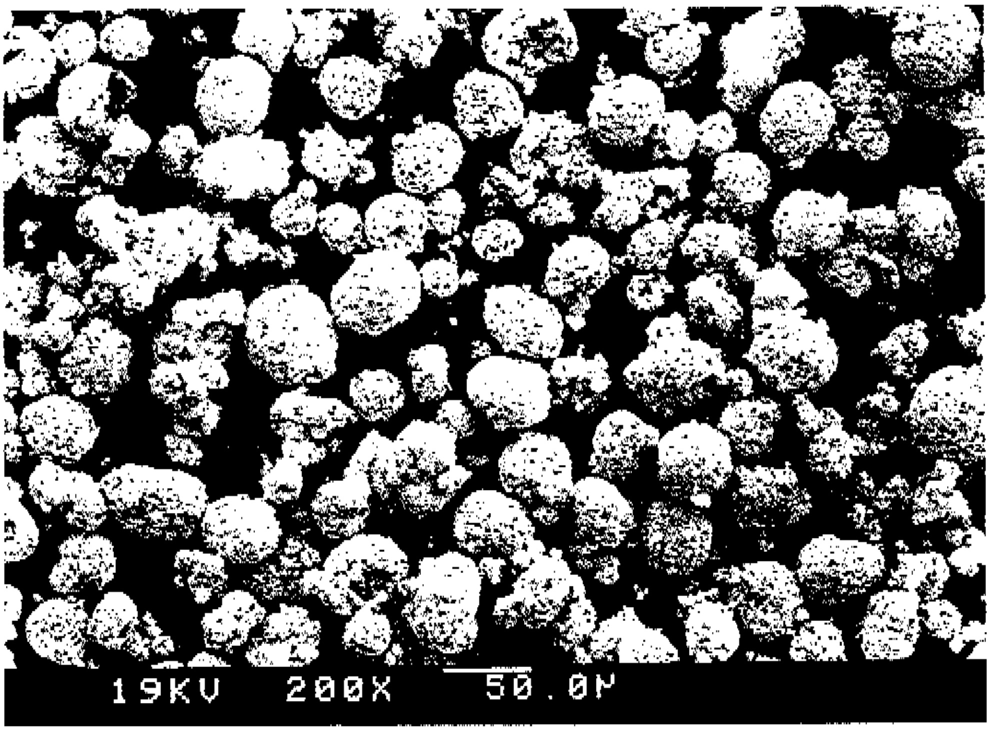

Figure A.5. WC/Co agglomerated-sintered; particle shape: spherical

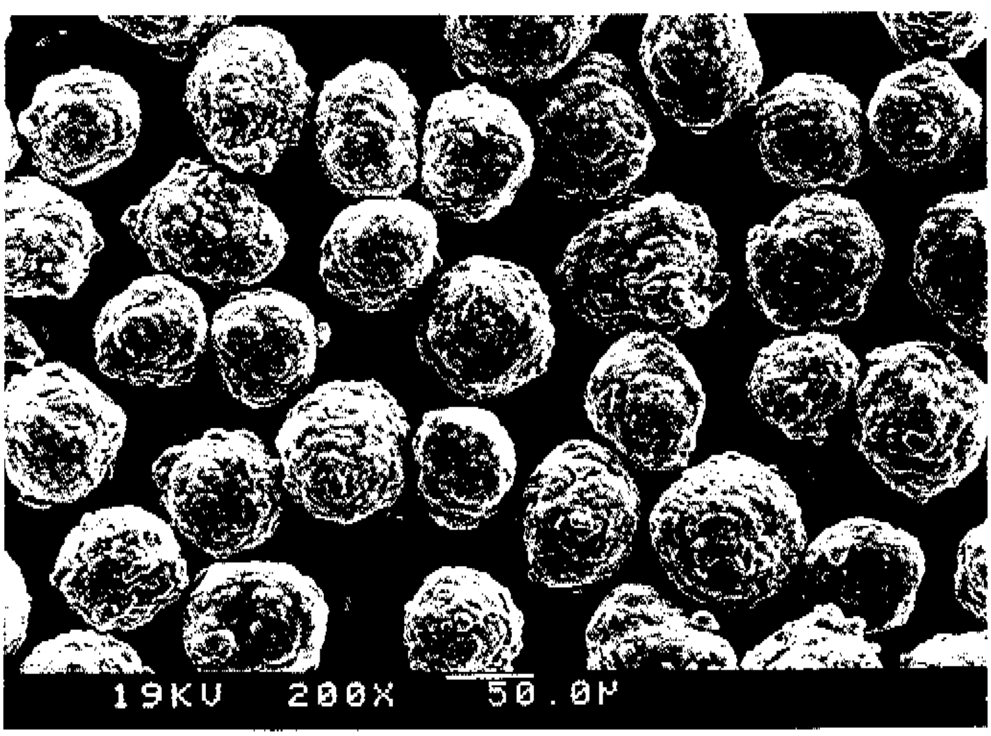

Figure A.6. NiAl porously coated; particle shape determined by core material; here: spherical

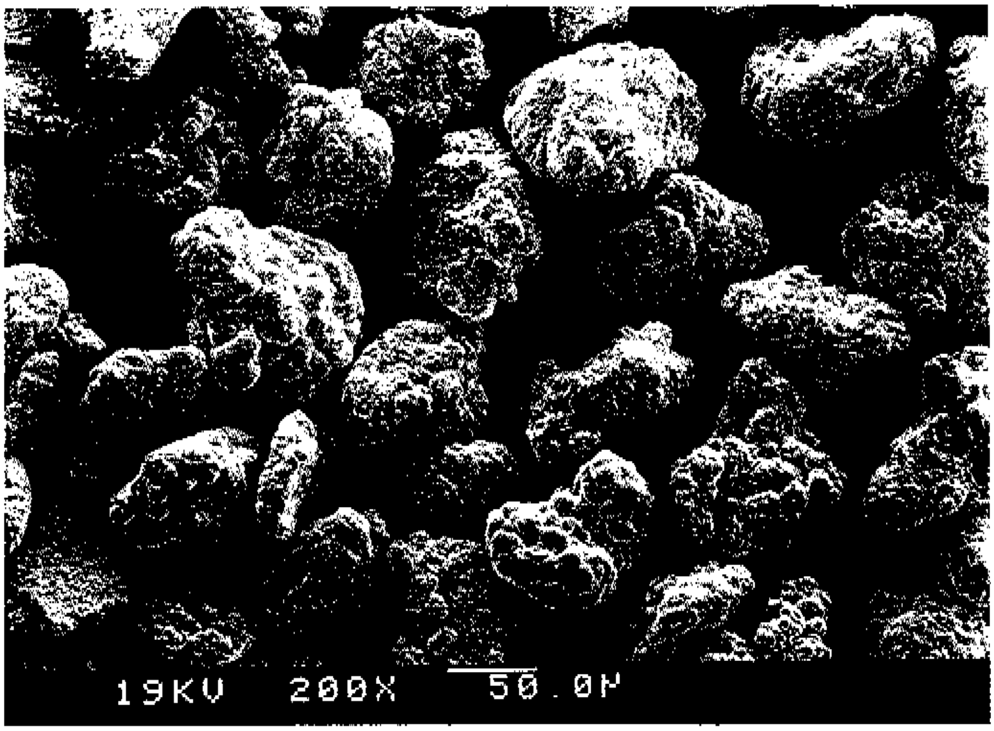

Figure A.7. Nickel graphite densely coated; particle shape determined by core material; here: blocky