INTERNATIONAL STANDARD

ISO 14232

First edition
2000-05-15

Thermal spraying — Powders — Composition and technical supply conditions

Projection thermique — Poudres — Composition et conditions techniques de livraison

Reference number
ISO 14232:2000(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 734 10 79
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14232 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*.

Annex A of this International Standard is for information only.

Introduction

The majority of commercially available thermal spray powders are classified on the basis of their composition and degree of purity. They may be specified and characterized according to the information contained in this International Standard which will hopefully lead to a greater understanding of the variety and the wide choice of thermal spray powders now available to the manufacturer and the user.

Due to the great number of thermal spray powders classified in this International Standard, well-known abbreviations are used. The properties of sprayed coatings are not discussed and may differ greatly from the properties of the original material due to specific thermal spraying conditions, such as gas composition, deposition efficiency, material flow rate and stand-off distance. The many applications of thermally sprayed coatings are not reviewed here because they have been described elsewhere in the technical literature.

Thermal spraying — Powders — Composition and technical supply conditions

1 Scope

This International Standard designates the chemical and physical properties of the powders that are commonly used in the production of thermally sprayed coatings.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3310-1:—[1)], *Test sieves — Requirements and tests — Part 1: Metal wire cloth sieves*.

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 of powders for thermal spraying — Property determination

3.1 Sampling and sample splitting

Sampling and sample splitting shall be done from a homogeneous mixture that is uniform in grain size. Directions for suitable methods and equipment for accomplishing this shall be in accordance with ISO 3954.

3.2 Chemical composition

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

3.3 Particle size range

Typical particle size ranges apply to thermal spraying powder units.

When particle size distribution is determined by particle size measurement in accordance with ISO 3310-1, the upper limits may be exceeded by 2 % by mass maximum and the lower limits may be exceeded by 5 % by mass

1) To be published. (Revision of ISO 3310-1:1990)

maximum. The apparent particle size depends on the measurement technique and hence the maximum permissible tolerances of the upper and lower particle size range also depend on the measuring method.

Measuring method, particle size range and maximum permissible tolerances for upper and lower particle size range shall be agreed upon between the powder manufacturer and the producer of the thermally sprayed coating to ensure reproducibility of the thermal spraying process.

Powder shall be supplied to suit the application and the thermal spray process. Examples of typical particle size ranges applicable to thermal spray processes are given below.

Typical particle size ranges, in micrometres, are:

— 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 size and its distribution. X-ray absorption and laser-beam scattering methods are preferred because of their higher reproducibility, rapidity and resolution compared with conventional screening methods.

The results of particle size and particle size distribution measurements are dependent on the methods used and in the case of agglomerated powders are affected by the solubility of the binder. It is, therefore, necessary to verify that the powder is suitable for the chosen test method. The powder test certificate shall state the test applied, in addition to the result of the particle size distribution measurement.

3.5 Process of manufacture — Particle shape

The process by which a powder is manufactured shall be indicated; e.g., fused, bonded, agglomerated, atomized, etc.

Particle shape and surfaces can be illustrated by means of scanning electron or stereo microscopy, and the images may be compared to those of referenced samples provided by the manufacturer to determine their similarity. Examples of the relationship between the manufacturing process and particle shape are given in annex A.

3.6 Apparent density

Apparent powder density shall be determined as specified in ISO 3923-2, and expressed in grams per cubic centimetre.

3.7 Flow properties – Flowability

Powder flowability shall be determined as specified in ISO 4490, and expressed in seconds per 50 g.

3.8 Microstructure

The microstructure of a powder particle can be determined by means of a metallographically-prepared cross-section of the particle. The preparation method is critical and shall be agreed upon between the manufacturer and the user.

3.9 Determination of phases

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

3.10 Summary

The relative importance of thermal spray powder properties as related to various materials and to different spraying processes is indicated in Table 1.

Table 1 — The relative importance of thermal spray powder properties for various categories of powder and for different processes

	Chemical composition	Particle size	Particle shape	Apparent density	Flow	Micro-structure	Phase composition	Melting range
Powder categories								
Pure metals	+++	+++	++	+	+	–	–	–
Metallic alloys	+++	+++	++	+	+	–	+	++[a]
Carbides, carbides with metals, carbides with metallic alloys	+++	+++	++	+	+	++	++	–
Oxides, phosphate and other non-carbide ceramics	+++	+++	++	+	+	+	+	–
Organic materials	+++	+++	+	+	++	–	–	+++[b]
Different thermal spray processes								
Plasma spraying	++	+++	++	–	+	–	++[c]	–
Flame spraying	++	+++	+	–	+++	–	–	+++[a]
High velocity flame spraying	++	+++	+++	++	+	–	++[c]	+

+++ Specification of this property is imperative/a critical property.

++ Specification of this property is recommended/an important property.

\+ Supplementary detail.

– Without significance.

[a] For self-fluxing (SF) alloys.

[b] In organic material spraying, decomposition temperature and oxidation resistance of the molten material, as well as toxicological characteristics, are important.

[c] Necessary detail for the spraying of carbides and oxides, e.g., ZrO_2-Y_2O_3.

4 Classification of powders

4.1 General

Powders for thermal spraying are classified on the basis of chemical composition and may be put into the following categories:

a) pure metals (4.2 and Table 2);

b) metallic alloys and composites (4.3 and Tables 3-11);

c) carbides, carbides with metals, carbides with metallic alloys and composites (4.4 and Table 12);

d) oxides, phosphates and other non-carbide ceramics (4.5 and Table 13);

e) organic materials (4.6).

Blended powders of several varying components are not included.

4.2 Pure metals

Table 2 — Pure metal powders

Code number	Chemical composition, %						
	Main constituent	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	–	–	–	–	–	–

4.3 Metallic alloys and composites

Table 3 — Self-fluxing metallic alloys and composite powders

Code number	Abbreviated designation	Chemical composition, %										
		C	Ni	Co	Cr	Cu	W	Mo	Fe	B	Si	Others max.
2.1	NiCuBSi 76 20	0,05 max.	balance	–	–	19 to 20	–	–	0,5 max	0,9 to 1,3	1,8 to 2,0	0,5
2.2	NiBSi 96	0.05 max.	balance	–	–	–	–	–	0,5 max	1,0 to 1,5	2,0 to 2,5	0,5
2.3	NiBSi 94	0,1 max.	balance	–	–	–	–	–	0,5 max	1,5 to 2,0	2,8 to 3,7	0,5
2.4	NiBSi 95	0,1 to 0,2	balance	–	–	–	–	–	2,0 max	1,2 to 1,7	2,2 to 2,8	0,5
2.5	NiCrBSi 90 4	0,1 to 0,2	balance	–	3 to 5	–	–	–	1,0 max	1,4 to 1,8	2,8 to 3,5	0,5
2.6	NiCrBSi 86 5	0,15 to 0,25	balance	–	4 to 6	–	–	–	3,0 to 3,5	0,8 to 1,2	2,8 to 3,2	0,5
2.7	NiCrBSi 88 5	0,15 to 0,25	balance	–	4 to 6	–	–	–	1,0 to 2,0	1,0 to 1,5	3,5 to 4,0	0,5
2.8	NiCrBSi 83 10	0,15 to 0,25	balance	–	8 to 12	–	–	–	1,5 to 3,5	2,0 to 2,5	2,3 to 2,8	0,5
2.9	NiCrBSi 85 8	0,15 to 0,25	balance	–	6 to 10	–	–	–	1,5 to 2,0	1,5 to 2,0	2,6 to 3,4	0,5
2.10	NiCrBSi 84 8	0,25 to 0,4	balance	–	7 to 10	–	–	–	1,7 to 2,5	1,5 to 2,2	3,2 to 4,0	0,5
2.11	NiCrBSi 88 4	0,3 to 0,4	balance	–	3,5 to 4,5	–	–	–	2 max	1,6 to 2,0	3,0 to 3,5	0,5
2.12	NiCrBSi 80 11	0,35 to 0,6	balance	–	10 to 12	–	–	–	2,5 to 3,5	2,0 to 2,5	3,5 to 4,0	0,5
2.13	NiCrWBSi 64 11 16	0,5 to 0,6	balance	–	10 to 12	–	15,5 to 16,5	–	3,5 to 4,0	2,3 to 2,7	3,0 to 3,5	0,5
2.14	NiCrCuMoBSi 67 17 3 3	0,5 to 0,7	balance	–	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	0,5
2.15	NiCrCuMoWBSi 64 17 3 3 3	0,4 to 0,6	balance	–	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	0,5
2.16	NiCrBSi 74 15	0,75 to 1,0	balance	–	16 to 17	–	–	–	3,5 to 5,0	2,8 to 3,5	3,6 to 4,5	0,5