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ISO 14919

Second edition
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Thermal spraying — Wires, rods and cords for flame and arc spraying — Classification — Technical supply conditions

Projection thermique — Fils, baguettes et cordons pour projection thermique à l'arc et au pistolet dans une flamme — Classification — Conditions techniques d'approvisionnement

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

ISO 14919 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 240, *Thermal spraying and thermally sprayed coatings*, in collaboration with ISO Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 14919:2001), which has been technically revised.

Introduction

Requests for official interpretations of any aspect of this standard should be directed to the secretariat of ISO/TC 107/WG 1 via your national standards body; a complete listing can be found at www.iso.org.

Thermal spraying — Wires, rods and cords for flame and arc spraying — Classification — Technical supply conditions

1 Scope

This International Standard specifies requirements for classification of metal and non-metal wires (solid and cored), rods, cords processed by means of thermal spraying, especially by arc and flame spraying.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10474:2013, *Steel and steel products — Inspection documents*

ISO 544:2011, *Welding consumables — Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings*

3 Classification

3.1 Classification according to the manufacturing process and resulting structure

The thermal spray materials are classified according to the manufacturing process and the resulting structure, as given in Table 1.

Table 1 — Classification of thermal spraying material and resulting structure

Number	Term	Manufacturing process	Structure
1	solid wire/rod	metallurgical manufacturing and forming	homogeneous composition
2	solid wire/rod	powder metallurgical manufacturing and forming	homogeneous composition
3	cored wire (tube shaped wire)	filling up a metal tube and compressed by means of forming	seamless metal shell with powder filling
4	cored wire (folded wire)	forming a metal sheet with powder filling, binder and compressed by means of drawing	metal shell with powder filling
5	cords	simultaneous extruding of powder, binder and organic sheath	plastic shell with powder filling
6	oxide ceramic rods	extruding and sintering respectively drying of ceramic material	porous rod consisting of bonded ceramic particles

3.2 Classification according to material groups and chemical composition

The material groups are given in Table 2, and the chemical composition shall comply with Tables 3 to 10.

Table 2 — Classification according to material groups

Code Number	Term
1	tin and tin alloys
2	zinc and zinc alloys
3	aluminium and aluminium alloys
4	copper and copper alloys
5	iron and iron alloys
6	nickel and nickel alloys
7	molybdenum
8	oxide ceramics

3.2.1 Tin and tin alloys

Table 3 — Tin and tin alloys

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
1.1	Sn99	Sn	≥ 99,95	total	≤ 0,05	1
				Sb	≤ 0,02	
				Ag	≤ 0,01	
				Bi	≤ 0,002	
				Cu	≤ 0,01	
				Fe	≤ 0,01	
				Pb	≤ 0,02	
				Al+Cd+Zn	≤ 0,002	
1.2	SnSbCu84	Sb Cu remainder Sn	7 to 8 3 to 4	Pb	≤ 0,35	1
				As	≤ 0,1	
				Bi	≤ 0,08	
				Fe	≤ 0,1	
				Al	≤ 0,01	
				Zn	≤ 0,01	
				other: total	≤ 0,2	

3.2.2 Zinc and zinc alloys

Table 4 — Zinc and zinc alloys

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
2.1	Zn99,99	Zn	≥ 99,99	total	≤ 0,010	1
				Pb	≤ 0,007	
				Cd	≤ 0,004	
				Pb+Cd	≤ 0,011	
				Sn	≤ 0,001	
				Fe	≤ 0,005	
				Cu	≤ 0,002	
				other: total	≤ 0,12	
2.2	Zn99	Zn	≥ 99	total	≤ 1,0	1
				Pb	≤ 0,05	
				Cd	≤ 0,005	
				Pb+Cd	≤ 0,06	
				Sn	≤ 0,001	
				Fe	≤ 0,01	
				Cu	≤ 0,7	
				Mo	≤ 0,01	
				Ti	≤ 0,16	
				Mg	≤ 0,01	
				Al	≤ 0,01	
				other: total	≤ 0,12	
2.3	ZnAl15	Zn Al	84 to 86 14 to 16	total	≤ 0,17	1
				Pb	≤ 0,007	
				Cd	≤ 0,004	
				Pb+Cd	≤ 0,011	
				Sn	≤ 0,001	
				Fe	≤ 0,02	
				Cu	≤ 0,01	
				Si	≤ 0,12	

3.2.3 Aluminium and aluminium alloys

Table 5 — Aluminium and aluminium alloys

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
3.2	Al99,5	Al	≥ 99,5	total	≤ 0,3	1
				Si	≤ 0,25	
				Fe	≤ 0,40	
				Ti	≤ 0,02	
				Cu	≤ 0,02	
				Zn	≤ 0,07	
				Mn	≤ 0,02	
				other: particular	≤ 0,03	
3.3	AlMg5	Mg	4,5 to 5,6	total	≤ 0,9	1
		Mn	0,05 to 0,20	Si	≤ 0,30	
		Cr	0,05 to 0,20	Fe	≤ 0,40	
		Ti	0,06 to 0,20	Cu	≤ 0,10	
		remainder Al		Zn	≤ 0,10	
				other: particular	≤ 0,15	
3.4	AlZn5	Zn	4,5 to 5,1	total	≤ 1	1
		remainder Al		Si	≤ 0,30	
				Fe	≤ 0,40	
				Cu	≤ 0,05	
				Sn	≤ 0,20	
				other: particular	≤ 0,05	
3.5	AlSi5	Si	4,5 to 6,0	total	≤ 1	1
		remainder Al		Si	≤ 0,30	
				Fe	≤ 0,80	
				Cu	≤ 0,30	
				Mn	≤ 0,05	
				Mg	≤ 0,05	
				Zn	≤ 0,10	
				Sn	≤ 0,20	
				other: particular	≤ 0,15	

Table 5 *(continued)*

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
3.6	AlSi12	Si remainder Al	11,0 to 13,0	total Fe Cu Mn Mg Zn Ti other particular: other total:	≤ 1 ≤ 0,80 ≤ 0,30 ≤ 0,15 ≤ 0,10 ≤ 0,20 ≤ 0,15 ≤ 0,05 ≤ 0,15	1

3.2.4 Copper and copper alloys

Table 6 — Copper and copper alloys

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
4.1	Cu99	Cu	≥ 99,9	other	≤ 0,01	1
4.2	CuZn37	Cu remainder Zn	62,0 to 64	Al Fe Mn Ni Pb Sb Sn other: total	≤ 0,03 ≤ 0,1 ≤ 0,1 ≤ 0,3 ≤ 0,1 ≤ 0,01 ≤ 0,1 ≤ 0,5	1
4.3	CuZn39	Cu Sn Si remainder Zn	56 to 62 0,5 to 1,5 0,1 to 0,5	Ni Mn Fe Al Pb other: total	≤ 1,5 ≤ 1,0 ≤ 0,5 ≤ 0,01 ≤ 0,03 ≤ 0,2	1
4.4	CuSn6	Sn remainder Cu	5,0 to 8,0	Fe Al Zn Pb P other: total	≤ 0,1 ≤ 0,01 ≤ 0,1 ≤ 0,02 0,01 to 0,4 ≤ 0,4	1

Table 6 *(continued)*

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
4.6	CuAl8	Al remainder Cu	7,5 to 9,5	Mn Ni Fe Si Zn other: total	≤ 1,8 ≤ 0,8 ≤ 0,5 ≤ 0,2 ≤ 0,2 ≤ 0,5	1
4.7	CuAl10	Al Fe remainder Cu	8,5 to 11 0,5 to 1,5	Ni+Co Pb Si Mn Zn other: total	≤ 1,0 ≤ 0,02 ≤ 0,1 ≤ 0,03 ≤ 0,02 ≤ 0,3	1

3.2.5 Iron and iron alloys

Table 7 — Iron and iron alloys

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
5.1	10Mn	C Mn remainder Fe	0,04 to 0,12 0,42 to 0,68	Si Cr Cu Ni P S	traces ≤ 0,15 ≤ 0,20 ≤ 0,15 ≤ 0,030 ≤ 0,030	1
5.3	80MnSi	C Si Mn remainder Fe	0,8 to 0,85 0,15 to 0,35 0,50 to 0,70	P S	≤ 0,035 ≤ 0,035	1
5.6	110MnCrTi5–5	C Si Mn Cr remainder Fe	0,97 to 1,23 0,12 to 0,38 1,76 to 2,27 1,65 to 1,95	Ti P S	0,13 to 0,35 ≤ 0,025 ≤ 0,025	1
5.7	X45Cr13 a) with Cu plating b) without Cu plating	C Si Mn Cr remainder Fe	0,3 to 0,50 ≤ 1,0 ≤ 1,0 12 to 14	P S	≤ 0,045 ≤ 0,030	1
5.8	X20CrMo13–1	C Si Mn Cr Mo remainder Fe	0,17 to 0,22 ≤ 1,0 ≤ 1,0 12 to 14 0,9 to 1,3	Ni P S	≤ 1,0 ≤ 0,045 ≤ 0,030	1

Table 7 *(continued)*

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
5.9	X 6CrAl22–4	C Si Mn Al Cr remainder Fe	≤ 0,055 ≤ 0,65 ≤ 0,45 3,5 to 5,5 21 to 23	P S	≤ 0,040 ≤ 0,025	1
5.10	X6CrNi19–9	C Si Mn Cr Ni remainder Fe	≤ 0,06 ≤ 1,5 ≤ 2,0 18 to 20 8,5 to 10,5	P S	≤ 0,030 ≤ 0,020	1
5.11	(X5CrNiMo17–12–2)[a]	C Si Mn Cr Mo Ni remainder Fe	≤ 0,08 ≤ 1,0 ≤ 2,0 16,5 to 18,5 2 to 2,5 10,5 to 13,5	P S	≤ 0,045 ≤ 0,030	1, 4
5.12	(X12CrNiMn18–8–6)[a]	C Si Mn Cr Ni remainder Fe	≤ 0,20 ≤ 1,0 5,5 to 8,0 17 to 20 7,5 to 9,5	P S	≤ 0,040 ≤ 0,025	1, 4
5.13	X12CrNi25–20	C Si Mn Cr Ni remainder Fe	≤ 0,15 ≤ 1,5 1,5 to 3,5 24 to 27 19 to 22	P S	≤ 0,025 ≤ 0,020	1
5.14	X25CrCuB26–3-3	C Cr Mn Si Cu B remainder Fe	≤ 0,3 ≤ 26 ≤ 1 ≤ 0,3 ≤ 3 ≤ 3	other	≤ 1	3, 4
5.15	X25MnAlSi7–5	C Al Mn Si remainder Fe	≤ 0,3 4 to 5 6 to 8 ≤ 1,0	other	≤ 1	3, 4
5.16	X39CrMo17–1 a) with Cu plating b) without Cu plating	C Si Mn Cr Mo remainder Fe	0,33 to 0,45 ≤ 1,0 ≤ 1,5 15,5 to 17,5 0,80 to 1,3	P S	≤ 0,040 ≤ 0,015	1

[a] Material is similar to that in brackets. Different limit values are underlined.

3.2.6 Nickel and nickel alloys

Table 8 — Nickel and nickel alloys

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
6.1	NiCu30Mn3Ti (NiCu30)	Ni Cu Mn Fe	≥ 62,0 27,0 to 35,0 1,0 to 4,0 1,0 to 2,5	Al C Si S Ti Nb other: total	≤ 0,5 ≤ 0,15 ≤ 1,0 ≤ 0,02 ≤ 1,0 ≤ 2,5 ≤ 0,5	1
6.2	Ni99	Ni	≥ 99,2	Cu C Fe Mg Mn S Si	≤ 0,1 ≤ 0,25 ≤ 0,4 ≤ 0,15 ≤ 0,3 ≤ 0,005 ≤ 0,2	1
6.3	NiCrFe15–20	Cr Fe Ni	14 to 19 19 to 25 ≥ 59	Cu C Mn Si	≤ 0,5 ≤ 0,15 ≤ 2,5 ≤ 2,0	1
6.4	NiCr20	Cr remainder Ni	18 to 21	Cu C Fe Mn Si S	≤ 0,5 ≤ 0,25 ≤ 0,5 ≤ 1,2 ≤ 0,5 ≤ 0,015	1
6.5	NiAl5	Al remainder Ni	4,5 to 5,5	Mn Ti Si Fe Cu C	≤ 0,3 ≤ 0,4 ≤ 0,5 ≤ 0,3 ≤ 0,08 ≤ 0,005	1, 3, 4, 5
6.6	NiAl20	Al remainder Ni	18 to 22	Fe Mn Si Cu C	≤ 0,3 ≤ 0,3 ≤ 0,5 ≤ 0,1 ≤ 0,25	3, 4[a]
6.7	NiAlMo5–5	Al Mo remainder Ni	4,5 to 5,5 ≤ 5	other	≤ 1	3, 4

Table 8 *(continued)*

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
6.8	NiCrAl20–6	Al Cr Mo remainder Ni	6 to 7 18 to 21 ≤ 5	other	≤ 1	3, 4
6.9	NiFeAlCr20–14–3	Al Cr Fe remainder Ni	14 to 15 3 to 5 17 to 23	other	≤ 1	3, 4
6.10	NiCrBSi	Cr Fe Si B C remainder Ni	≤ 9 ≤ 3 ≤ 3,2 ≤ 1,6 ≤ 0,3	other	≤ 1	5
6.11	NiCr22Mo9Nb	Ni Cr Mo Nb	≤ 58,0 18 to 23 8 to 10 3,15 to 4,15	C SI Mn TiAl Co Cu P S remainder Fe	0,03 to 0,10 ≤ 0,5 ≤ 0,5 ≤ 0,2 ≤ 0,1 1,5 to 3 ≤ 0,02 ≤ 0,015	1, 4
6.12	NiCu30Mn	Ni Cu Fe	≤ 63,0 26,5 to 34,0 1,00 to 2,5	C SI Mn S Ti Al	≤ 0,15 ≤ 0,50 ≤ 2,00 ≤ 0,020 ≤ 0,30 ≤ 0,5	1
a Filling is typically performed by a solid wire.						

3.2.7 Molybdenum

Table 9 — Molybdenum

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
7.1	Mo	Mo	≥ 99,95	other	≤ 0,05	2

3.2.8 Ceramics

Table 10 — Oxide ceramics

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
8.1	$95ZrO_2$-5CaO	ZrO_2 CaO	≥ 92 5 to 7	Al_2O_3 SiO_2 Fe_2O_3 TiO_2 Na_2O MgO	≤ 0,7 ≤ 0,4 ≤ 0,04 ≤ 0,4 ≤ 0,02 ≤ 0,07	5, 6

Table 10 *(continued)*

Code number	Symbol	Alloying elements mass fraction in %		Other elements mass fraction in %		Manufacturing process
8.2	$70ZrO_2$-30CaO	ZrO_2 CaO	≥ 68 28 to 31	Al_2O_3 TiO_2 Na_2O MgO	≤ 0,7 ≤ 0,4 ≤ 0,02 ≤ 0,07	5
8.3	Cr_2O_3	Cr_2O_3	≥ 90,0	Al_2O_3 CaO SiO_2 Fe_2O_3 TiO_2 MgO	≤ 4 ≤ 0,2 ≤ 5 ≤ 0,3 ≤ 0,3 ≤ 0,1	5, 6
8.4	Al_2O_3	Al_2O_3	≥ 98	CaO SiO_2 Fe_2O_3 TiO_2 Na_2O MgO	≤ 0,2 ≤ 0,8 ≤ 0,09 ≤ 0,03 ≤ 0,06 ≤ 0,3	5, 6
8.5	$97Al_2O_3$ –$3TiO_2$	Al_2O_3 TiO_2	≥ 94 ≥ 3	CaO SiO_2 Fe_2O_3 Na_2O MgO Mn_3O_4	≤ 0,2 ≤ 1,0 ≤ 0,5 ≤ 0,04 ≤ 0,5 ≤ 0,05	5
8.6	$87Al_2O_3$-$13TiO_2$	Al_2O_3 TiO_2	85 to 87 13 to 15	CaO SiO_2 Fe_2O_3 Na_2O MgO	≤ 0,2 ≤ 0,5 ≤ 0,3 ≤ 0,2 ≤ 0,3	5, 6
8.7	$60Al_2O_3$-$40TiO_2$	Al_2O_3 TiO_2	58 to 60 40 to 42	CaO SiO_2 Fe_2O_3 Na_2O MgO	≤ 0,2 ≤ 0,5 ≤ 0,3 ≤ 0,2 ≤ 0,3	5, 6
8.8	$70Al_2O_3$-$30SiO_2$	Al_2O_3 SiO_2	72 to 78 22 to 28	CaO SiO_2 Fe_2O_3 Na_2O MgO	≤ 0,2 ≤ 0,5 ≤ 0,3 ≤ 0,2 ≤ 0,3	5
8.9	$70Al_2O_3$-30MgO	Al_2O_3 MgO	76 to 82 18 to 24	CaO SiO_2 Fe_2O_3 Na_2O MgO	≤ 0,2 ≤ 0,5 ≤ 0,3 ≤ 0,2 ≤ 0,3	5

4 Sizes and tolerances

Standard sizes and tolerances of diameter in millimetres for thermal spray wires, rods and cords are given in Tables 11, 12 and 13. If required, smaller ranges of tolerances can be agreed between customer and manufacturer/supplier. The straightness of the rods shall allow the spray material to be fed satisfactorily.

Table 11 — Wire diameters

Size [mm]	**Tolerance** [mm]
1,6	+ 0; −0,05
1,62	+ 0; −0,05
2,0	+ 0; −0,06
2,3	+ 0; −0,06
2,4	+ 0; −0,06
2,5	+ 0; −0,06
3,0	+ 0; −0,07
3,17	+ 0; −0,07
3,48	+ 0; −0,07
4,76	+ 0; −0,07

Table 12 — Rod diameters

Size [mm]	**Tolerance** [mm]
4,8	+ 0,05; −0,2
6,3	+ 0,05; −0,2

Table 13 — Cord diameters

Size [mm]	**Tolerance** [mm]
3,17	±0,1
4,75	±0,1

5 Properties

5.1 Mechanical properties

The mechanical properties of the wires shall be suitable for trouble-free feeding and processing. If required, the mechanical properties should be specified among manufacturer, supplier and customer.

The temper of thermal spray wire should be suitable for uninterrupted feeding on thermal spray equipment.

NOTE Very hard, poorly tempered thermal spray wires are difficult to handle, hard to straighten, and cause excessive wear on vital gun parts such as drive rolls, guides and contact tubes or nozzles. On the other hand, too soft thermal spray wires (e.g. aluminium, tin, zinc) may cause problems with feeding.

5.2 Surface properties

The surface of the thermal spray wire shall be smooth and free of corrosion products, slivers and splits, shrinkholes, splices and scales, damages as well as neckings, welds and laps. Moreover, foreign matter that would adversely affect the thermal spray material's characteristics or properties of the sprayed coating is to be avoided.

For arc spraying, martensitic and ferritic steel thermal spray wire shall be protected with a plating of copper to prevent corrosion during storage. The plating shall cover the whole wire surface without visible defects.

For alloys number 5.7 (Table 7) two variants are available: 5.7a) with copper plating and 5.7b) with another suitable plating. This condition is also valid for 5.16a) and 5.16b). A very small amount of