
**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

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

Throughout the text of this standard, read "...this European Standard..." to mean "...this International Standard...".

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Foreword

The text of EN ISO 14919:2001 has been prepared by Technical Committee CEN/TC 240 "Thermal spraying and thermally sprayed coatings", the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 107 "Metallic and other inorganic coatings".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2002, and conflicting national standards shall be withdrawn at the latest by February 2002.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This 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

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 revisions 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.

EN 10204:1991

Metallic products – Types of inspection documents

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	ceramic rods	extruding and sintering 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 %	manu- facturing process
1.1	Sn99	Sn min. 99,95	total $\leq 0,05$ Sb $\leq 0,02$ Ag $\leq 0,01$ Bi $\leq 0,002$ Cu $\leq 0,01$ Fe $\leq 0,01$ Pb $\leq 0,02$ Al+Cd+Zn $\leq 0,002$	1
1.2	SnSbCu84	Sb 7 to 8 Cu 3 to 4 remainder Sn	Pb $\leq 0,35$ As $\leq 0,1$ Bi $\leq 0,08$ Fe $\leq 0,1$ Al $\leq 0,01$ Zn $\leq 0,01$ other: total $\leq 0,2$	1

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 %	manu- facturing process
2.1	Zn99,99	Zn min. 99,99	total $\leq 0,010$ Pb $\leq 0,005$ Cd $\leq 0,005$ Pb+Cd $\leq 0,006$ Sn $\leq 0,001$ Fe $\leq 0,003$ Cu $\leq 0,002$ other: total $\leq 0,12$	1
2.2	Zn99	Zn min. 99	total $\leq 1,0$ Pb $\leq 0,005$ Cd $\leq 0,005$ Pb+Cd $\leq 0,006$ Sn $\leq 0,001$ Fe $\leq 0,01$ Cu $\leq 0,7$ Mo $\leq 0,01$ Ti $\leq 0,16$ Mg $\leq 0,01$ Al $\leq 0,01$ other: total $\leq 0,12$	1
2.3	ZnAl15	Zn 84 to 86 Al 14 to 16	total $\leq 0,17$ Pb $\leq 0,005$ Cd $\leq 0,005$ Pb+Cd $\leq 0,006$ Sn $\leq 0,001$ Fe $\leq 0,05$ Cu $\leq 0,01$ Si $\leq 0,12$	1

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 %	manu- facturing process
3.1	Al99,98	Al min. 99,98	total $\leq 0,02$ Si $\leq 0,01$ Zn $\leq 0,01$ Fe $\leq 0,006$ Cu $\leq 0,003$ Ti $\leq 0,003$ other: particular $\leq 0,003$	1

(continued)

Table 5 (concluded)

code number	symbol	alloying elements mass fraction in %	other elements mass fraction in %	manu- facturing process
3.2	Al99,5	Al min. 99,5	total $\leq 0,5$ Si $\leq 0,3$ Fe $\leq 0,4$ Ti $\leq 0,05$ Cu $\leq 0,05$ Zn $\leq 0,07$ Mn $\leq 0,05$ other: particular $\leq 0,03$	1
3.3	AlMg5	Mg 4,5 to 5,5 Mn 0 to 0,5 Cr 0 to 0,3 Ti 0,10 to 0,25 remainder Al	total $\leq 0,9$ Si $\leq 0,25$ Fe $\leq 0,40$ Cu $\leq 0,05$ Zn $\leq 0,2$ other: particular $\leq 0,05$	1
3.4	AlZn5	Zn 4,5 to 5,1 remainder Al	total ≤ 1 Si $\leq 0,30$ Fe $\leq 0,40$ Cu $\leq 0,05$ Sn $\leq 0,20$ other: particular $\leq 0,05$	1
3.5	AlSi5	Si 4,5 bis 5,5 remainder Al	total ≤ 1 Si $\leq 0,30$ Fe $\leq 0,40$ Cu $\leq 0,05$ Sn $\leq 0,20$ other: particular $\leq 0,05$	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 %	manu- facturing process
4.1	Cu99	Cu $\geq 99,9$	other $\leq 0,01$	1
4.2	CuZn37	Cu 62,0 to 64 remainder Zn	Al $\leq 0,03$ Fe $\leq 0,1$ Mn $\leq 0,1$ Ni $\leq 0,3$ Pb $\leq 0,1$ Sb $\leq 0,01$ Sn $\leq 0,1$ other: total $\leq 0,5$	1
4.3	CuZn39	Cu 56 to 62 Sn 0,5 to 1,5 Si 0,1 to 0,5 remainder Zn	Ni $\leq 1,5$ Mn $\leq 1,0$ Fe $\leq 0,5$ Al $\leq 0,01$ Pb $\leq 0,03$ other: total $\leq 0,2$	1
4.4	CuSn6	Sn 5,0 to 8,0 remainder Cu	Fe $\leq 0,1$ Al $\leq 0,01$ Zn $\leq 0,1$ Pb $\leq 0,02$ P 0,01 to 0,4 other: total $\leq 0,4$	1
4.5	CuSn12	Sn 11,0 to 13,0 remainder Cu	Fe $\leq 0,1$ Al $\leq 0,01$ Zn $\leq 0,1$ Pb $\leq 0,02$ P 0,01 to 0,4 other: total $\leq 0,4$	1
4.6	CuAl8	Al 7,5 to 9,5 remainder Cu	Mn $\leq 1,8$ Ni $\leq 0,8$ Fe $\leq 0,5$ Si $\leq 0,2$ Zn $\leq 0,2$ other: total $\leq 0,5$	1

(continued)

Table 6 (concluded)

code number	symbol	alloying elements mass fraction in %	other elements mass fraction in %	manufacturing process
4.7	CuAl10	Al 9,0 to 11,0 Fe 2,0 to 4,0 Mn 1,5 to 3,5 remainder Cu	Ni $\leq 1,0$ Pb $\leq 0,05$ Si $\leq 0,2$ Zn $\leq 0,5$ other: total $\leq 0,3$	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	10 Mn	C 0,04 to 0,12 Mn 0,42 to 0,68 remainder Fe	Si traces Cr $\leq 0,15$ Cu $\leq 0,20$ Ni $\leq 0,15$ P $\leq 0,030$ S $\leq 0,030$	1
5.2	10 MnSi4	C 0,07 to 0,14 Si 0,07 to 0,14 Mn 1,3 to 1,6 remainder Fe	Cr $\leq 0,15$ Cu $\leq 0,20$ Mo $\leq 0,15$ Ni $\leq 0,15$ P $\leq 0,025$ S $\leq 0,025$	1
5.3	80 MnSi	C 0,8 to 0,85 Si 0,15 to 0,35 Mn 0,50 to 0,70 remainder Fe	P $\leq 0,035$ S $\leq 0,035$	1
5.4	150 Cr4	C 1,4 to 1,6 Si 0,15 to 0,30 Mn 0,50 to 0,70 Cr 1,3 to 1,5 remainder Fe	P $\leq 0,035$ S $\leq 0,035$	1
5.5	110 Cr3	C 0,9 to 1,2 Si 0,20 to 0,40 Mn 0,20 to 0,40 Cr 0,9 to 1,1 remainder Fe	P $\leq 0,030$ S $\leq 0,030$	1

(continued)

Table 7 (continued)

code number	symbol	alloying elements mass fraction in %	other elements mass fraction in %	manu- facturing process
5.6	110 MnCrTi5 5	C 0,97 to 1,23 Si 0,12 to 0,38 Mn 1,76 to 2,27 Cr 1,65 to 1,95 remainder Fe	Ti 0,13 to 0,35 P $\leq 0,025$ S $\leq 0,025$	1
5.7	X 45 Cr13 a) with Cu plating b) without Cu plating	C 0,3 to 0,50 Si $\leq 1,0$ Mn $\leq 1,0$ Cr 12 to 14 remainder Fe	P $\leq 0,045$ S $\leq 0,030$	1
5.8	X 20 CrMo 13 1	C 0,17 to 0,22 Si $\leq 1,0$ Mn $\leq 1,0$ Cr 12 to 14 Mo 0,9 to 1,3 remainder Fe	Ni $\leq 1,0$ P $\leq 0,045$ S $\leq 0,030$	1
5.9	X 6 CrAl 22 4	C $\leq 0,055$ Si $\leq 0,65$ Mn $\leq 0,45$ Al 3,5 to 5,5 Cr 21 to 23 remainder Fe	P $\leq 0,040$ S $\leq 0,025$	1
5.10	X 6 CrNi19 9	C $\leq 0,06$ Si $\leq 1,5$ Mn $\leq 2,0$ Cr 18 to 20 Ni 8,5 to 10,5 remainder Fe	P $\leq 0,030$ S $\leq 0,020$	1
5.11	X 5 CrNiMo17 12 2	C $\leq 0,07$ Si $\leq 1,0$ Mn $\leq 2,0$ Cr 16,5 to 18,5 Mo 2 to 2,5 Ni 10,5 to 13,5 remainder Fe	P $\leq 0,045$ S $\leq 0,030$	1
5.12	X 12 CrNiMn 18 8 6	C $\leq 0,20$ Si $\leq 1,0$ Mn 5,5 to 8,0 Cr 17 to 20 Ni 7,5 to 9,5 remainder Fe	P $\leq 0,040$ S $\leq 0,025$	1
5.13	X 12 CrNi25 20	C $\leq 0,15$ Si $\leq 1,5$ Mn 1,5 to 3,5 Cr 24 to 27 Ni 19 to 22 remainder Fe	P $\leq 0,025$ S $\leq 0,020$	1

(continued)

Table 7 (concluded)

code number	symbol	alloying elements mass fraction in %	other elements mass fraction in %	manu- facturing process
5.14	X 25 CrCuB26 3 3	C ≤ 0,3 Cr ≤ 26 Mn ≤ 1 Si ≤ 0,3 Cu ≤ 3 B ≤ 3 remainder Fe	other ≤ 1	3, 4
5.15	X 25 MnAlSi7 5	C ≤ 0,3 Al 4 to 5 Mn 6 to 8 Si ≤ 1,0 remainder Fe	other ≤ 1	3, 4

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 %	manu- facturing process
6.1	NiCu30	Ni min. 62,0 Cu 27,0 to 35,0 Mn 1,0 to 4,0 Fe 1,0 to 2,5	Al ≤ 0,5 C ≤ 0,15 Si ≤ 1,0 S ≤ 0,02 Ti ≤ 1,0 Nb ≤ 2,5 other: total ≤ 0,5	1
6.2	Ni99	Ni min. 99,2	Cu ≤ 0,1 C ≤ 0,25 Fe ≤ 0,4 Mg ≤ 0,15 Mn ≤ 0,3 S ≤ 0,005 Si ≤ 0,2	1
6.3	NiCrFe15 20	Cr 14 to 19 Fe 19 to 25 Ni min. 59	Cu ≤ 0,5 C ≤ 0,15 Mn ≤ 2,5 Si ≤ 2,0	1
6.4	NiCr20	Cr 18 to 21 remainder Ni	Cu ≤ 0,5 C ≤ 0,25 Fe ≤ 0,5 Mn ≤ 1,2 Si ≤ 0,5 S ≤ 0,015	1

(continued)

Table 8 (concluded)

code number	symbol	alloying elements mass fraction in %	other elements mass fraction in %	manufacturing process
6.5	NiAl5	Al 4,5 to 5,5 remainder Ni	Mn $\leq 0,3$ Ti $\leq 0,4$ Si $\leq 0,5$ Fe $\leq 0,3$ Cu $\leq 0,08$ C $\leq 0,005$	1, 3, 4, 5
6.6	NiAl20	Al 18 to 22 remainder Ni	Fe $\leq 0,3$ Mn $\leq 0,3$ Si $\leq 0,5$ Cu $\leq 0,1$ C $\leq 0,25$	3, 4*
6.7	NiAlMo5 5	Al 4,5 to 5,5 Mo ≤ 5 remainder Ni	other ≤ 1	3, 4
6.8	NiCrAl20 6	Al 6 to 7 Cr 18 to 21 Mo ≤ 5 remainder Ni	other ≤ 1	3, 4
6.9	NiFeAlCr20 14 3	Al 14 to 15 Cr 3 to 5 Fe 17 to 23 remainder Ni	other ≤ 1	3, 4
6.10	NiCrBSi	Cr ≤ 9 Fe ≤ 3 Si $\leq 3,2$ B $\leq 1,6$ C $\leq 0,3$ remainder Ni	other ≤ 1	5

* 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 $\geq 99,95$	other $\leq 0,05$	2

3.2.8 Ceramics

Table 10: Oxide ceramics

code number	symbol	alloying elements mass fraction in %	other elements mass fraction in %	manu- facturing process
8.1	ZrO ₂ / CaO 95/5	ZrO ₂ ≥ 92 CaO 5 to 7	Al ₂ O ₃ ≤ 0,7 SiO ₂ ≤ 0,4 Fe ₂ O ₃ ≤ 0,04 TiO ₂ ≤ 0,4 Na ₂ O ≤ 0,02 MgO ≤ 0,07	6
8.2	ZrO ₂ / CaO 70/30	ZrO ₂ ≥ 68 CaO 28 to 31	Al ₂ O ₃ ≤ 0,7 TiO ₂ ≤ 0,4 Na ₂ O ≤ 0,02 MgO ≤ 0,07	5
8.3	Cr ₂ O ₃	Cr ₂ O ₃ ≥ 90,0	Al ₂ O ₃ ≤ 4 CaO ≤ 0,2 SiO ₂ ≤ 0,5 Fe ₂ O ₃ ≤ 0,3 TiO ₂ ≤ 0,3 MgO ≤ 0,1	5, 6
8.4	Al ₂ O ₃	Al ₂ O ₃ ≥ 98	CaO ≤ 0,2 SiO ₂ ≤ 0,8 Fe ₂ O ₃ ≤ 0,09 TiO ₂ ≤ 0,03 Na ₂ O ≤ 0,06 MgO ≤ 0,3	5, 6
8.5	Al ₂ O ₃ / TiO ₂ 97/3	Al ₂ O ₃ ≥ 94 TiO ₂ ≥ 3	CaO ≤ 0,2 SiO ₂ ≤ 1 Fe ₂ O ₃ ≤ 0,5 Na ₂ O ≤ 0,04 MgO ≤ 0,5 Mn ₃ O ₄ ≤ 0,05	5, 6
8.6	Al ₂ O ₃ / TiO ₂ 87/13	Al ₂ O ₃ 85 to 87 TiO ₂ 13 to 15	CaO ≤ 0,2 SiO ₂ ≤ 0,5 Fe ₂ O ₃ ≤ 0,3 Na ₂ O ≤ 0,2 MgO ≤ 0,3	6
8.7	Al ₂ O ₃ / TiO ₂ 60/40	Al ₂ O ₃ 58 to 60 TiO ₂ 40 to 42	CaO ≤ 0,2 SiO ₂ ≤ 0,5 Fe ₂ O ₃ ≤ 0,3 Na ₂ O ≤ 0,2 MgO ≤ 0,3	6
8.8	Al ₂ O ₃ / SiO ₂ 70/30	Al ₂ O ₃ 72 to 78 SiO ₂ 22 to 28	CaO ≤ 0,2 SiO ₂ ≤ 0,5 Fe ₂ O ₃ ≤ 0,3 Na ₂ O ≤ 0,2 MgO ≤ 0,3	5

(continued)

Table 10 (concluded)

code number	symbol	alloying elements mass fraction in %	other elements mass fraction in %	manu- facturing process
8.9	Al ₂ O ₃ / MgO 70/30	Al ₂ O ₃ 76 to 82 MgO 18 to 24	CaO ≤ 0,2 SiO ₂ ≤ 0,5 Fe ₂ O ₃ ≤ 0,3 Na ₂ O ≤ 0,2 MgO ≤ 0,3	5, 6

4 Sizes and tolerances

Standard sizes and tolerances of diameter in millimetres for thermal spray wires, rods and cords are given in table 11, 12 and 13. If it is required, smaller ranges of tolerances can be arranged between customer and manufacturer/-supplier. The straightness of the rods has to be formed so that the material is conveyed without faults.

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
2,5	+0; -0,06
3,0	+0; -0,07
3,17	+0; -0,07
3,48	+0; -0,07
4,0	+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
7,9	+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.

NOTE: The temper of thermal spray wire should be suitable for uninterrupted feeding on thermal spray equipment. 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 has to 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 has to 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. A very small amount of lubricant that will not degrade the sprayed coating may be applied to the thermal spray wire to permit smooth and low-friction feeding through the thermal spray equipment.

NOTE: Using cored wires manufactured according to clause 3, table 1, should not be lubricated or treated by any liquids.

The surface of cords has to be smooth and free of neckings. The surface of rods has to be free of neckings and without scratches. Rods shall not exhibit end kinks or end-to-end warpage that could adversely affect rod feed.

5.3 Workability: Winding of wires

Wires shall be wound onto rims, coils and spools or inserted into barrels in one length. Kinks and sharp bends shall be avoided. The end shall be fastened to prevent unwinding. The beginning of the wire shall be marked so that it can be located readily. The outermost layer on spools shall be at least 3 mm from the rim of the flanges of the spool. The diameter of an unwound single wire coil shall not exceed 120 % of the spool's outer diameter but shall not be smaller than the spool's inner diameter. The wire shall not contain a twist. An unwound winding shall remain flat when laying on the ground. Given careful handling, the coils shall unwind without problems.

6 Sampling and testing

Any testing of the thermal spraying material shall be carried out with the sample taken from the beginning of the thermal spraying material pack.

In order to assess a thermal spray material, a sprayability test can be arranged among supplier and customer.