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Resistance welding — Materials for electrodes and ancillary equipment

Soudage par résistance — Matériaux pour électrodes et équipements annexes

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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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The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining*.

This fourth edition cancels and replaces the third edition (ISO 5182:2008), which has been technically revised.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Resistance welding — Materials for electrodes and ancillary equipment

1 Scope

This International Standard specifies the characteristics of materials for resistance welding electrodes and ancillary equipment which are used for carrying current and transmitting force to the work.

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 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ASTM E1004, *Standard practice for determining electrical conductivity using the electromagnetic (eddy-current) method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
softening temperature
maximum temperature that, if maintained for 2 h, will result in a reduction in ambient temperature hardness of a maximum of 15 % of the "as received" value

4 Classification

4.1 Group A — Copper and copper alloys

This group defines four types of material in accordance with Table 1.

Table 1 — Group A — Classification of copper and copper alloys

Type	Description
1	Non-heat-treatable alloys of high conductivity and medium hardness, the wrought forms of which are given their strengths by cold working during manufacture.
2	Alloys which are harder than type 1 and in which the mechanical properties have been developed by heat treatment during manufacture or by a combination of heat treatment and cold working.
3	Heat-treated alloys which have superior mechanical properties to type 2 but a lower electrical conductivity than either type 1 or type 2.
4	Alloys having certain specialised properties which may, in some cases, be obtained either by cold working or by heat treatment. Alloys of this type are not necessarily interchangeable with each other.

4.2 Group B — Sintered materials

This group comprises six types of material based upon the constituents used in accordance with Table 2.

Table 2 — Group B — Classification of sintered materials

Type	Description
10 and **11**	Sintered products of copper and tungsten.
12	Sintered product of copper and tungsten carbide.
13	Sintered and worked product of molybdenum.
14	Sintered and worked product of tungsten.
15	Sintered product of tungsten and silver.

4.3 Group C — Dispersion-strengthened copper (DSC) alloys

This group comprises two types of materials (see Table 3):

— C 20/1, C 20/2 and C 20/3, manufactured by internal oxidation;

— C 20/4, C 20/5 and C 20/6, manufactured by ball milling or mechanical alloying.

5 Specifications

5.1 Requirements

The materials shall comply with Table 3.

5.2 Chemical composition

The chemical compositions are given in Table 3.

5.3 Mechanical properties

The material hardness shall not be less than as given in Table 3.

NOTE When these materials are used for resistance welding equipment, the required properties are different from those of materials used for general purposes.

5.4 Electrical properties

The electrical conductivity, given in mega-Siemens per metre (MS/m) or as a percentage of the conductivity of the International Annealed Copper Standard (IACS), of materials shall be not less than those given in Table 3.

6 Methods of test

6.1 Vickers hardness test

The Vickers hardness test shall be carried out with a 300 N load in accordance with ISO 6507-1.

6.2 Electrical properties

The electrical properties shall be measured in accordance with ASTM E1004. When it is not possible to use this method, the test shall be carried out as agreed between the suppliers, the purchaser, and a mutually acceptable arbitrator.

NOTE Electrical conductivity, when evaluated with eddy-current instruments, is usually expressed as a percentage of the conductivity of the International Annealed Copper Standard (IACS).

6.3 Softening temperature test

Hardness and conductivity tests normally guarantee the quality of the material and allow verification of the softening temperature. The softening temperature test is not normally carried out on each batch of material.

Pending the finalization of a standard method for carrying out the softening temperature test, the test can only be made as agreed between suppliers and purchaser.

7 Designation

Materials shall be designated by the group, type and number (see Table 3).

EXAMPLE 1 CuCr1 is designated:

ISO 5182:2016 – A 2/1

where

ISO 5182 is the reference of this International Standard;

A is the material group (see Clause 4);

2 is the material type (see Clause 4);

1 is the CuCr1 material number (see Table 3).

EXAMPLE 2 W75Cu is designated:

ISO 5182:2016 – B 10

where

ISO 5182 is the reference of this International Standard;

B is the material group (see Clause 4);

10 is the material type (see Clause 4).

8 Application

For typical applications, see Annex A.

WARNING — For alloys containing beryllium, precautions shall be taken in case of dry grinding, dry polishing or welding to avoid inhalation of dust or fumes over a certain period of time.

9 Hardness conversions

See Annex B.

Table 3 — Composition and properties of materials

Group	Type	No.	Designation	Nominal alloying elements %	Forms available mm	Hardness HV 30 min.	Electrical conductivity MS/m min.	Electrical conductivity % IACS	Softening temperature °C min.
A	1	1	Cu-ETP	Cu (+Ag) min. 99,90	drawn ≥25	85	57	98	150
					drawn <25	100	57	98	
					forged	45	57	98	
					cast	40	50	86	
		2	Cu-EPT1	Cu min 99,90 O max.0,04	wire d ≤ 2,5/ -0,04	[a]	57,5	99	150
		3	CuAg0,10P	Ag 0,08 to 0,12	drawn <25	90	55	95	150
		4	Cu-PHC	P 0,001 to 0,006	drawn	85	57	98	150
	2	1	CuCr1	Cr 0,5 to 1,2	drawn ≥25	125	44	76	475
					drawn <25	140	44	76	
					forged	100	44	76	
					cast	85	44	76	
		2	CuCr1Zr	Cr 0,5 to 1,4 Zr 0,03 to 0,3	drawn ≥25	135	43	74	500
					drawn <25	140	43	74	
					forged	100	43	74	
		3	CuCrZr	Cr 0,4 to 1 Zr 0,02 to 0,15	hardened	150	43	74	500
					ground <45	150	43	74	
		4	CuZr	Zr 0,1 to 0,2	drawn	140	47	81	500
					ground <30	130	47	81	
	3	1	CuCo2Be	Co 2,0 to 2,8 Be 0,4 to 0,7	drawn ≥25	260	23	40	500
					drawn < 25	270	23	40	
					forged	260	23	40	
					cast	250	23	40	
		2	CuNi2Si	Ni 1,6 to 2,5 Si 0,4 to 0,8	drawn ≥25	180	17	29	450
					drawn <25	190	18	31	
					forged	170	19	33	
					cast	160	17	29	
		3	CuNi2Be	Ni 1,4 to 2,4 Be 0,2 to 0,6	drawn <40	240	24	42	450
		4	CuCo1Ni1Be	Co 0,8 to 1,3 Ni 0,8 to 1,3 Be 0,4 to 0,7	drawn <40	250	23	40	475

[a] Rm min = 270 MPa, Rp/Rm ≥ 0,7.

NOTE The nominal alloying elements of the listed grades are for information only. The materials are manufactured to the properties shown in the table. Group A and C alloys are copper based; refractory materials are listed in group B.

Table 3 *(continued)*

Group	Type	No.	Designation	Nominal alloying elements	Forms available	Hardness HV 30	Electrical conductivity		Softening temperature
				%	mm	min.	MS/m min.	% IACS	°C min.
A	4	1	CuNi1P	Ni 0,8 to 1,2 P 0,15 to 0,25	drawn ≥25	210	29	50	450
					drawn <25	220	29	50	
					forged	130	29	50	
					cast	110	29	50	
		2	CuBe2	Be 1,8 to 2,1 Co-Ni-Fe 0,20 to 0,30	drawn ≥25	330	14	25	300
					drawn <25	340	14	25	
					forged	350	14	25	
					cast	350	14	25	
		4	CuAl10Ni5Fe4	Al 8,5 to 11 Fe 3,0 to 5,0 Ni 4,0 to 6,0 Mn 0 to 1,0	forged	170	4	7	
					cast	170	4	7	
		5	CuZn40Pb2	Cu 57 to 59, Pb 1,6 to 2,5	bars and tubes, diameter 60 mm max.	120	15	17	650
		6	CuZn21Si3P	Cu 76 Zn 21 Si 3 , P 0,05	bars and tubes diameter 60 mm and above	130	4,5	7,8	
B	10		W75Cu	Cu 25		220	17	29	1 000
	11		W78Cu	Cu 23		240	16	27	1 000
	12		WC70Cu	Cu 30		300	12	20	1 000
	13		Mo	Mo 99,5		150	17	29	1 000
	14		W	W 99,5		420	17	29	1 000
	15		W65Ag	35 Ag		140	29	50	900
C	20	1	CuAl2O3	Al_2O_3 1,1	extruded	150	44	76	980
		2	CuAl2O3	Al_2O_3 0,6	extruded	140	45,6	78	980
					work hardened	150	45,6	78	980
		3	CuAl2O3	Al_2O_3 0,25	extruded	120	54	92	950
					work hardened	140	54	92	980
		4	CuAl2O3	Al_2O_3 1,5 B max. 0,2	extruded	155	43	74	980
		5	CuAl2O3 C15790	Al_2O_3 0,92 B max. 0,22	extruded	140	45	77	980
		6	C15780	Al_2O_3 0,70 B max. 0,22	extruded	130	50	86	950

[a] Rm min = 270 MPa, Rp/Rm ≥ 0,7.

NOTE The nominal alloying elements of the listed grades are for information only. The materials are manufactured to the properties shown in the table. Group A and C alloys are copper based; refractory materials are listed in group B.

Annex A
(informative)

Typical applications

Typical applications for the materials in Table 3 are given in Table A.1.

Table A.1 — Typical applications

Material	Spot welding	Seam welding	Projection welding	Flash or butt welding	Auxiliary applications
A 1/1	—	—	—	—	Unstressed current-carrying parts; laminated shunts
A 1/2	—	Fuel tank welding Narrow seams, coated sheets, stainless steel,	—	—	
A 1/3	Electrodes for welding aluminium Electrodes for welding coated steel (zinc, tin, aluminium, lead)	Electrode wheels for welding aluminium Electrode wheels for welding coated steel (zinc, tin, lead, etc.)	—	Electrodes or inserts for welding mild steel	Electrodes for high-frequency resistance welding of non-ferrous metals
A 1/4	—	—	—	—	Unstressed current-carrying parts; laminated shunts; weldable cables
A 2/1	Electrodes for welding mild steel Electrode holders and shafts and back-ups	Electrode wheels for welding mild steel	Large electrodes	Electrodes or inserts for welding mild and carbon steels, stainless steels and heat-resistant steels	Stressed current-carrying parts Backing for sintered electrode materials of group B
A 2/2	Electrodes for welding mild steel and coated steel	Electrode wheels for welding mild steel and coated steel	Electrodes and inserts	—	Stressed current-carrying parts Parts for guns, e.g. holders, shafts and arms
A 2/3	Electrodes for welding mild steel, coated steel and advanced high-strength steel	Electrode wheels for welding mild steel and coated steel	Electrodes and inserts	—	Stressed current carrying parts Parts for guns, e.g. holders, shafts
A 2/4	Electrodes for welding mild steel, coated steel and advanced high-strength steel	Electrode wheels for welding mild steel and coated steel	Electrodes and inserts	—	Stressed current-carrying parts
A 3/1	Electrodes for welding stainless and heat-resistant steels Stressed electrode holders, shafts and arms	Welding wheels for stainless and heat-resistant steels Shafts and bushings	Electrodes and inserts	Electrodes or inserts under high clamping force	Stressed current-carrying parts

Table A.1 *(continued)*

Material	Spot welding	Seam welding	Projection welding	Flash or butt welding	Auxiliary applications
A 3/2	Stressed electrode holders, shafts and arms	Shafts and bushings	—	—	Stressed current-carrying parts
A 3/3	Electrodes for welding stainless and heat-resistant steels Stressed electrode holders, shafts and arms	Welding wheels for stainless and heat-resistant steels Shafts and bushings	Electrodes and inserts	Electrodes or inserts under high clamping force	Stressed current-carrying parts
A 3/4	Electrodes for welding stainless and heat-resistant steels Stressed electrode holders, shafts and arms	Welding wheels for stainless and heat-resistant steels Shafts and bushings	Electrodes and inserts	Electrodes or inserts under high clamping force	Stressed current-carrying parts
A 4/1	Electrode holders and bent arms	Shafts and bushings	—	—	Stressed current-carrying parts
A 4/2	Electrode holders and shafts under extreme mechanical stress	Machine arms under extreme mechanical stress	Electrodes or inserts under high electrode forces	Long electrodes for flash welding	—
A 4/4	Electrode holders	Shafts and bushings under light electrical loading	Platens and electrodes	—	—
A 4/5	Bars and tubes for gun arms, inserts in welding tools	—	Inserts in tools	—	Various parts in tooling and welding machines
A4/6	Bars and tubes for gun arms, inserts in welding tools				
B 10	—	—	Inserts for welding mild steel	Inserts for welding mild steel under high stress	Inserts for hot riveting and hot up-setting
B 11	—	—	—	—	Inserts for hot riveting and hot up-setting
B 12	—	—	Inserts for welding stainless steel	Small electrodes or inserts for welding steel	Inserts for hot riveting and hot up-setting
B 13	Inserts for welding copper-based high-conductivity materials	—	—	—	Inserts for hot riveting and hot up-setting Inserts for resistance brazing

Table A.1 *(continued)*

Material	Spot welding	Seam welding	Projection welding	Flash or butt welding	Auxiliary applications
B 14	Inserts for welding copper-based high-conductivity materials	—	—	—	Inserts for hot riveting and hot up-setting Inserts for resistance brazing
B 15	—	—	—	—	Electrodes for high-frequency resistance welding of ferrous materials
C 20	Electrodes for welding mild steel, coated steel and advanced high strength steel	Electrode wheels for welding mild steel and coated steel	Electrodes and inserts	—	Stressed current-carrying parts