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Soft solder alloys — Chemical compositions and forms

Alliages de brasage tendre — Compositions chimiques et formes

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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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9453 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 12, *Soldering materials*.

This second edition cancels and replaces the first edition (ISO 9453:1990), 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/SC 12 via your national standards body. A complete listing of these bodies can be found at http://www.iso.org.

Introduction

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning soft solder alloy compositions given in Table 3.

ISO takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured ISO that he/she is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO. Information may be obtained from:

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Attention is drawn to the possibility that some of the elements of this document (in particular the alloy compositions) may be the subject of patent rights other than those identified above. ISO shall not be held responsible for identifying any or all such patent rights.

Any alloys which are currently believed to be subject to any restriction on use are denoted with footnote [h] in Table 3.

Patent rights vary between the countries of manufacture, sale, use and final destination; suppliers or users remain responsible for establishing the exact legal position relevant to their own situation.

Soft solder alloys — Chemical compositions and forms

1 Scope

This International Standard specifies the requirements for chemical composition for the following families of soft solder alloys:

— tin-lead, with and without antimony, bismuth, cadmium, copper, and silver;

— tin-antimony;

— tin-bismuth;

— tin-copper, with and without silver;

— tin-indium, with and without silver and bismuth;

— tin-silver, with and without copper and bismuth;

— tin-zinc, with and without bismuth.

It also includes an indication of the forms generally available.

2 Normative references

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

ISO 3677, *Filler metal for soft soldering, brazing and braze welding — Designation*

3 Terms and definitions

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

3.1
soft solder
metallic filler material used to join metallic parts, which has a melting temperature (liquidus) lower than that of the parts to be joined, usually lower than 450 °C, and which wets the parent metals

3.2
unit of product
unit used to define the requirements for marking soft solders, and which varies with the form of the solder

See Table 1.

Table 1 — Variations of unit of product with form of solder

Form of solder	Unit of product
Ingot, bar, slab, stick or rod	Single ingot, bar, slab, stick or rod
Wire or ribbon	Single coil or reel
Wrought preforms and rings, spheres, pellets or powder	Individual packaged quantity
Powder in pastes or creams	Individual packaged quantity

3.3
batch
collection of one or more units of product, made in a single production operation

4 Chemical composition

The chemical composition of the soft solder, sampled and analysed in accordance with Clause 6, shall be as given for the appropriate material in Table 2 or Table 3.

5 Forms of delivery

Soft solders conforming to this International Standard shall be supplied in one of the following forms: ingot, slab, stick, bar, rod, wire, pellets, preforms, spheres, ribbons, powder, or pastes and creams containing powder.

Solders supplied in the form of rod, wire or preforms may be supplied with or without an integral flux, subject to agreement between the supplier and the purchaser.

NOTE Not all the solder compositions given in the tables are necessarily available in all the product forms listed.

6 Sampling and analysis

Pending the publication of International Standards for sampling and methods of analysis for soft solder alloys, the methods used shall, in cases of dispute, be agreed between the supplier and the purchaser.

7 Marking, labelling and packaging

Each batch of solder supplied in accordance with this International Standard shall be marked with the information indicated by a cross in Table 4.

The information in Table 4 shall be applied to the product forms as follows:

a) for ingots and slabs, by stamping, or for inkjet marking on the surface of each unit of product;

b) for sticks, bars, rods and wire in coil, either on a label securely attached to each unit of product, or on a label on the package in which the units of product are contained;

c) for wire or ribbon on reels, on a label on each reel;

d) for pellets, performs, spheres, powder, paste or cream, on a label on each individually packaged quantity.

All product forms shall also be labelled with any health and safety warnings required by the relevant rules and regulations of the country of manufacture, or as specified in the order.

Table 2 — Chemical compositions of lead containing solder alloys (tin-lead, lead-tin, tin-lead-antimony, tin-lead-bismuth, tin-lead-cadmium, tin-lead-copper, tin-lead-silver, and lead-silver)

Group	Alloy No. [a]	Alloy Designation according to ISO 3677 [b]	Melting or solidus/ liquidus temperature °C [c]	Chemical composition, mass fraction in % [d, e]													
				Sn	Pb	Sb	Bi	Cd	Cu	Au	In	Ag	Al	As	Fe	Ni	Zn
Tin-lead binary alloys solidus temperature 183 °C	101	S-Sn63Pb37	183	62,5 to 63,5	Rem	0,20	0,10	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	102	S-Sn63Pb37E	183	62,5 to 63,5	Rem	0,05	0,05	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	103	S-Sn60Pb40	183/190	59,5 to 60,5	Rem	0,20	0,10	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	104	S-Sn60Pb40E	183/190	59,5 to 60,5	Rem	0,05	0,05	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
Lead-tin binary alloys solidus temperature 183 °C	111	S-Pb50Sn50	183/215	49,5 to 50,5	Rem	0,20	0,10	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	112	S-Pb50Sn50E	183/215	49,5 to 50,5	Rem	0,05	0,05	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	113	S-Pb55Sn45	183/226	44,5 to 45,5	Rem	0,50	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	114	S-Pb60Sn40	183/238	39,5 to 40,5	Rem	0,50	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	115	S-Pb65Sn35	183/245	34,5 to 35,5	Rem	0,50	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	116	S-Pb70Sn30	183/255	29,5 to 30,5	Rem	0,50	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	117	S-Pb80Sn20	183/280	19,5 to 20,5	Rem	0,50	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
Lead-tin binary alloys solidus temperature > 183 °C	121	S-Pb85Sn15	226/290	14,5 to 15,5	Rem	0,50	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	122	S-Pb90Sn10	268/302	9,5 to 10,5	Rem	0,50	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	123	S-Pb95Sn5	300/314	4,5 to 5,5	Rem	0,50	0,10	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	124	S-Pb98Sn2	320/325	1,8 to 2,2	Rem	0,12	0,10	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
Tin-lead-antimony	131	S-Sn63Pb37Sb	183	62,5 to 63,5	Rem	0,20 to 0,50	0,10	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	132	S-Sn60Pb40Sb	183/190	59,5 to 60,5	Rem	0,20 to 0,50	0,10	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	133	S-Pb50Sn50Sb	183/216	49,5 to 50,5	Rem	0,20 to 0,50	0,10	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	134	S-Pb58Sn40Sb2	185/231	39,5 to 40,5	Rem	2,0 to 2,4	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	135	S-Pb69Sn30Sb1	185/250	29,5 to 30,5	Rem	0,5 to 1,8	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	136	S-Pb74Sn25Sb1	185/263	24,5 to 25,5	Rem	0,5 to 2,0	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	137	S-Pb78Sn20Sb2	185/270	19,5 to 20,5	Rem	0,5 to 3,0	0,25	0,005	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001

Table 2 (*continued*)

Group	Alloy No. [a]	Alloy Designation according to ISO 3677 [b]	Melting or solidus/ liquidus temperature °C [c]	Chemical composition, mass fraction in % [d, e]													
				Sn	Pb	Sb	Bi	Cd	Cu	Au	In	Ag	Al	As	Fe	Ni	Zn
Tin-lead-bismuth	141	S-Sn60Pb38Bi2	180/185	59,5 to 60,5	Rem	0,20	2,0 to 3,0	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	142	S-Pb49Sn48Bi3	178/205	47,5 to 48,5	Rem	0,20	2,5 to 3,5	0,002	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
Tin-lead-cadmium	151	S-Sn50Pb32Cd18	145	49,5 to 50,5	Rem	0,20	0,10	17,5 to 18,5	0,08	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
Tin-lead-copper	161	S-Sn60Pb39Cu1	183/190	59,5 to 60,5	Rem	0,20	0,10	0,002	1,2 to 1,6	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
	162	S-Sn50Pb49Cu1	183/215	49,5 to 50,5	Rem	0,20	0,10	0,002	1,2 to 1,6	0,05	0,10	0,10	0,001	0,03	0,02	0,01	0,001
Tin-lead-silver	171	S-Sn62Pb36Ag2	179	61,5 to 62,5	Rem	0,20	0,10	0,002	0,08	0,05	0,10	1,8 to 2,2	0,001	0,03	0,02	0,01	0,001
Lead-silver	181	S-Pb98Ag2	304/305	0,25	Rem	0,20	0,10	0,002	0,08	0,05	0,10	2,0 to 3,0	0,001	0,03	0,02	0,01	0,001
	182	S-Pb95Ag5	304/370	0,25	Rem	0,20	0,10	0,002	0,08	0,05	0,10	5,0 to 6,0	0,001	0,03	0,02	0,01	0,001
Lead-silver-tin	191	S-Pb93Sn5Ag2	296/301	4,8 to 5,2	Rem	0,20	0,10	0,002	0,08	0,05	0,10	1,2 to 1,8	0,001	0,03	0,02	0,01	0,001

[a] For information on IEC short alloy names, see Table A.1.

[b] In the proposed revision of ISO 3677, "S-" should be deleted from the alloy designation.

[c] The temperatures are for information purposes and are not specified requirements for the alloy.

[d] All single figure limits are maximum values.

[e] Elements shown as “Rem” (i.e. Remainder) are calculated as differences from 100 %.

Table 3 — Chemical compositions of lead-free solder alloys (tin-antimony, tin-bismuth, tin-copper, tin-indium, tin-silver and more complex compositions)

Group	Alloy No. [a]	Alloy Designation according to ISO 3677 [b]	Melting or solidus/ liquidus temperature °C [c]	Chemical composition, mass fraction in % [d, e]													
				Sn	Pb [f]	Sb	Bi	Cu	Au	In	Ag	Al	As	Cd	Fe	Ni	Zn
Tin-antimony	201	S-Sn95Sb5	235/240	Rem	0,10	4,5 to 5,5	0,10	0,05	0,05	0,10	0,10	0,001	0,03	0,002	0,02	0,01	0,001
Bismuth- tin	301	S-Bi58Sn42	139	41 to 43	0,10	0,10	Rem	0,05	0,05	0,10	0,10	0,001	0,03	0,002	0,02	0,01	0,001
Tin-copper	401	S-Sn99Cu1 (Sn99,3Cu0,7)	227	Rem	0,10	0,10	0,10	0,5 to 0,9	0,05	0,10	0,10	0,001	0,03	0,002	0,02	[g]	0,001
	402	S-Sn97Cu3	227/310	Rem	0,10	0,10	0,10	2,5 to 3,5	0,05	0,10	0,10	0,001	0,03	0,002	0,02	0,01	0,001
Tin-copper-silver	501	S-Sn98Cu1Ag (Sn99Cu0,7Ag0,3)	217/227	Rem	0,10	0,10	0,06	0,5 to 0,9	0,05	0,10	0,2 to 0,4	0,001	0,03	0,002	0,02	0,01	0,001
	502	S-Sn95Cu4Ag1	217/353	Rem	0,10	0,10	0,08	3,5 to 4,5	0,05	0,10	0,8 to 1,2	0,001	0,03	0,002	0,02	0,01	0,001
	503	S-Sn92Cu6Ag2	217/380	Rem	0,10	0,10	0,08	5,5 to 6,5	0,05	0,10	1,8 to 2,2	0,001	0,03	0,002	0,02	0,01	0,001
Indium-tin	601	S-In52Sn48	118	47,5 to 48,5	0,10	0,10	0,10	0,05	0,05	Rem	0,10	0,001	0,03	0,002	0,02	0,01	0,001
Tin-indium-silver-bismuth	611	S-Sn87In8Ag4Bi1 [h] (Sn88In8Ag3,5Bi0,5)	197/208	Rem	0,10	0,10	0,3 to 0,7	0,05	0,05	7,5 to 8,5	3,2 to 3,8	0,001	0,03	0,002	0,02	0,01	0,001
	612	S-Sn91In4Ag4Bi1 [h] (Sn92In4Ag3,5Bi0,5)	210/215	Rem	0,10	0,10	0,3 to 0,7	0,05	0,05	3,5 to 4,5	3,2 to 3,8	0,001	0,03	0,002	0,02	0,01	0,001
Tin-silver	701	S-Sn96Ag4 (Sn96,3Ag3,7)	221/228	Rem	0,10	0,10	0,10	0,05	0,05	0,10	3,5 to 3,9	0,001	0,03	0,002	0,02	0,01	0,001
	702	S-Sn97Ag3	221/224	Rem	0,10	0,10	0,10	0,05	0,05	0,10	2,8 to 3,2	0,001	0,03	0,002	0,02	0,01	0,001
	703	S-Sn96Ag4 (Sn96,5Ag3,5)	221	Rem	0,10	0,10	0,10	0,05	0,05	0,10	3,3 to 3,7	0,001	0,03	0,002	0,02	0,01	0,001
	704	S-Sn95Ag5	221/240	Rem	0,10	0,10	0,10	0,05	0,05	0,10	4,8 to 5,2	0,001	0,03	0,002	0,02	0,01	0,001
Tin-silver-copper	711	S-Sn96Ag3Cu1 [h] (Sn96,5Ag3Cu0,5)	217/220	Rem	0,10	0,10	0,10	0,3 to 0,7	0,05	0,10	2,8 to 3,2	0,001	0,03	0,002	0,02	0,01	0,001
	712	S-Sn95Ag4Cu1 [h] (Sn95,8Ag3,5Cu0,7)	217/218	Rem	0,10	0,10	0,10	0,5 to 0,9	0,05	0,10	3,3 to 3,7	0,001	0,03	0,002	0,02	0,01	0,001

Table 3 (*continued*)

Group	Alloy No. [a]	Alloy Designation according to ISO 3677 [b]	Melting or solidus/ liquidus temperature °C [c]	Chemical composition, mass fraction in % [d, e]													
				Sn	Pb [f]	Sb	Bi	Cu	Au	In	Ag	Al	As	Cd	Fe	Ni	Zn
Tin-silver-copper	713	S-Sn95Ag4Cu1 [h] (Sn95,5Ag3,8Cu0,7)	217/226 [i]	Rem	0,10	0,10	0,10	0,5 to 0,9	0,05	0,10	3,6 to 4,0	0,001	0,03	0,002	0,02	0,01	0,001
	714	S-Sn95Ag4Cu1 [h] (Sn95,5Ag4Cu0,5)	217/229	Rem	0,10	0,10	0,10	0,3 to 0,7	0,05	0,10	3,8 to 4,2	0,001	0,03	0,002	0,02	0,01	0,001
Tin-silver-bismuth-copper	721	S-Sn95Ag3Bi1Cu1 [h] (Sn96Ag2,5Bi1Cu0,5)	213/218	Rem	0,10	0,10	0,8 to 1,2	0,3 to 0,7	0,05	0,10	2,3 to 2,7	0,001	0,03	0,002	0,02	0,01	0,001
Tin-zinc	801	S-Sn91Zn9	199	Rem	0,10	0,10	0,10	0,05	0,05	0,10	0,10	0,001	0,03	0,002	0,02	0,01	8,5 to 9,5
Tin-zinc-bismuth	811	S-Sn89Zn8Bi3	190/197	Rem	0,10	0,10	2,8 to 3,2	0,05	0,05	0,10	0,10	0,001	0,03	0,002	0,02	0,01	7,5 to 8,5

a For information on IEC short alloy names see Annex A.

b In the proposed revision of ISO 3677, "S-" should be deleted from the alloy designations, and these specified more precisely. See proposed alloy designations in brackets.

c The temperatures given under the heading “Melting or solidus/liquidus temperature” are for information purposes and are not specified requirements for the alloys.

d All single figure limits are maximum values as impurities. Ranges are given for alloying elements.

e Elements shown as “Rem” (i.e. Remainder) are calculated as differences from 100 %.

f Lead figure of up to 0,20 % can be used in applications not affected by existing legislation which requires lower lead levels, where agreed between purchaser and supplier.

g The Nickel content as an impurity is not specified, however attention is drawn to the fact that patents have been granted for alloys containing Sn, Cu and Ni.

h Alloy subject to patent rights, see introduction for patent holders.

i Values measured by Differential Scanning Calorimetry (DSC). Alternatively, an eutectic temperature of 217 °C can be measured by the thermocouple measuring method.

Table 4 — Marking requirements for soft solders

Mark	Ingots	Slabs	Sticks	Bars	Rods	Wire	Ribbon	Pellets	Preforms	Powder	Paste/cream	Spheres
Alloy number or alloy designation	X	X	X	X	X	X	X	X	X	X	X	X
Batch No.	X	X	X	X	X	X	X	X	X	X	X	X
Date of manufacture	—	—	—	—	—	—	—	—	X	X	X	X
Storage conditions	—	—	—	—	—	—	—	—	X	X	X	X
Mass and quantity (where applicable)	—	—	—	—	—	X	X	X	X	X	X	X
Manufacturer's name or trade mark	—	—	—	—	—	X	X	X	X	X	X	X

Annex A
(informative)

Comparison between alloy numbers in ISO 9453 and short names and chemical compositions according to IEC 61190-1-3