INTERNATIONAL STANDARD

ISO 4381

Third edition
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Plain bearings — Lead and tin casting alloys for multilayer plain bearings

Paliers lisses — Alliages moulés à base de plomb et à base d'étain pour paliers lisses multicouches

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Foreword

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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 4381 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions*.

This third edition cancels and replaces the second edition (ISO 4381:1991) which has been technically revised.

Annex A of this International Standard is for information only.

Plain bearings — Lead and tin casting alloys for multilayer plain bearings

1 Scope

This International Standard specifies requirements for bearing metals based on lead and tin casting alloys for multilayer plain bearings.

NOTE Environmental concerns will, in the future, restrict the use of some materials such as lead.

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 4384-1, *Plain bearings — Hardness testing of bearing metals — Part 1: Compound materials.*

ISO 4384-2, *Plain bearings — Hardness testing of bearing metals — Part 2: Solid materials.*

ISO 4386-2, *Plain bearings — Metallic multilayer plain bearings — Part 2: Destructive testing of bond for bearing metal layer thicknesses equal to or greater than 2 mm.*

3 Requirements

3.1 Chemical composition

The chemical composition shall be within the limits specified in Tables 1 and 2, where single figures denote maximum values.

The chemical analysis is decisive for the acceptance of the bearing metals.

3.2 Material properties

Material properties shall be in accordance with the data given in Tables 1 and 2.

The Brinell hardness at 20 °C is regarded as the test and acceptance value. All other indicated values are mean values or ranges and are regarded as typical values for the designer. In view of the range of possible alloy compositions and the marked influence exerted by the cooling conditions on the mechanical properties, relatively large deviations from the indicated values are to be expected in individual cases.

3.3 Selection of material

Guidance on the uses of bearing metals and the hardness of the mating bearing part (shaft) is given in annex A.

Table 1 — Lead casting alloys

Chemical element			Chemical composition, % (*m*/*m*)		
			PbSb15SnAs	**PbSb15Sn10**	**PbSb10Sn6**
Pb			Remainder	Remainder	Remainder
Sb			13,5 to 15,5	14 to 16	9 to 11
Sn			0,9 to 1,7	9 to 11	5 to 7
Cu			0,7	0,7	0,7
As			0,8 to 1,2	0,6	0,25
Bi			0,1	0,1	0,1
Fe			0,1	0,1	0,1
Al			0,01	0,01	0,01
Zn			0,01	0,01	0,01
Total others			0,2	0,2	0,2
Material properties of test bar					
Brinell hardness [a] HB 10/250/180	20 °C	min.	18	21	16
	50 °C	≈	15	16	16
	120 °C	≈	14	14	14
	150 °C	≈	10	10	8
0,2 % Proof stress $R_{p0,2}$ N/mm^2	20 °C	≈	39	43	39
	50 °C	≈	37	32	32
	100 °C	≈	25	30	27
Bond strength, R_{Ch}, between bearing metal (limiting value; see ISO 4386-2) and steel with C = 0,1 % (*m*/*m*) bearing metal thickness ⩾ 6 mm N/mm^2		≈	60	70	65
Rotating bending fatigue, R_{rbf}, 10^7 cycles, N/mm^2		≈	± 24	± 25	± 21
Linear thermal expansion coefficient, α_l 10^{-6}/K		≈	25	24	25,3
Melting range °C		≈	240 to 350	240 to 270 [b]	240 to 260 [b]
Casting range °C		≈	450 to 500	480 to 520	480 to 520
Density, ρ kg/dm^3		≈	9,7	9,9	10,3

[a] For hardness testing, see ISO 4384-1 and ISO 4384-2.

[b] The upper limit of the melting range will be 380 °C if the copper content is higher than 0,5 % (*m*/*m*).

Table 2 — Tin casting alloys

Chemical element			Chemical composition, % (m/m)	
			SnSb12Cu6Pb	SnSb8Cu4
Sn			Remainder	Remainder
Sb			11 to 13	7 to 8
Cu			5 to 7	3 to 4
Pb			1 to 3	0,35
As			0,1 [a]	0,1 [b]
Bi			0,08	0,08
Fe			0,1	0,1
Al			0,01	0,01
Zn			0,01	0,01
Total others			0,4	0,2
Material properties of test bar				
Brinell hardness [c] HB10/250/180	20 °C	min.	25	22
	50 °C	≈	20	17
	120 °C	≈	12	11
	150 °C	≈	8	8
0,2 % Proof stress, $R_{p,0,2}$ N/mm^2	20 °C	≈	61	47
	50 °C	≈	60	44
	100 °C	≈	36	27
Bond strength, R_{Ch}, between bearing metal (limiting value; see ISO 4386-2) and steel with C = 0,1 % (m/m) bearing metal thickness ⩾ 6 mm N/mm^2		≈	40	80
Rotating bending fatigue, R_{rbf} 10^7cycles, N/mm^2		≈	± 28	± 31
Linear thermal expansion coefficient, α_l 10^{-6}/K		≈	22,7	23,9
Melting range °C		≈	183 to 400	233 to 360
Casting range °C		≈	480 to 520	440 to 460
Density, ρ kg/dm^3		≈	7,4	7,3

a In special cases a maximum of 0,8 % (m/m) is permissible.

b In special cases a maximum of 0,5 % (m/m) is permissible.

c For hardness testing, see ISO 4384-1 and ISO 4384-2.

4 Designation

EXAMPLE A bearing metal having the chemical composition indicated by the symbol PbSb15Sn10 is designated as follows:

Bearing metal ISO 4381 – PbSb15Sn10

Annex A
(informative)

Guidance on use of bearing metals and the hardness of the mating bearing part (shaft)

Bearing alloy	Characteristics and principal uses	Minimum hardness of the shaft [a]
PbSb15SnAs	Suitable only for pure sliding stresses at low load and low sliding velocities in the hydrodynamic range; good embeddability. Almost exclusively cast on to steel strip by means of continuous casting processes resulting in an extremely high cooling speed. Used for wrapped bushes and thin-walled bearing liners with a wall thickness of up to about 3 mm as well as for thrust washers, bushes for camshafts in internal combustion engines, gear bushes, connecting rod and main bearings in smaller piston compressors.	160 HB
PbSb15Sn10	Suitable for pure sliding stresses at mean loads and mean sliding velocities in the hydrodynamic range; low impact stress; good embeddability. Used at mean stresses for plain bearings, tilting pads, cross heads and cone breakers.	
PbSb10Sn6	Suitable for pure sliding stresses at low load and mean sliding velocities in the hydrodynamic range, moderate impact stress; good embeddability.	
SnSb12Cu6Pb	Good sliding properties at mean load and high to low sliding velocities in the hydrodynamic range; good impact stress; sensitive to reversed bending stress and edge compression; high wear resistance in the case of rough journals (grey cast iron). Used for plain bearings for turbines, compressors, electric machines and gears.	
SnSb8Cu4	Good sliding properties, conformability and high toughness; good embeddability; suitable for high sliding velocities in the hydrodynamic range, mean load; impact stress at low frequency; insensitive to reversed bending stress. Used for high loaded rolling mill bearings; for the production of wrapped bushes, thin-walled bearing liners with a wall thickness of up to about 3 mm and thrust washers.	

[a] In multilayer plain bearings the difference between the hardness of the bearing material and the shaft material should be such that welding under working conditions is safely avoided. The working conditions, in particular the lubrication conditions, have considerable influence on the selection of the shaft material. For this reason, the recommended hardness value for the shaft material is a minimum value. In general, unquenched and untempered shaft materials are used in the case of bearing materials based on lead and tin.