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# Plain bearings — Bearings containing dispersed solid lubricants

*Paliers lisses - Paliers contenant des lubrifiants solides dispersés*

ICS: 21.100.10





Reference number
ISO/DIS 20054:2016(E)

## Foreword

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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.

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ISO 20054 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 7, *Special types of plain bearings*.

# Plain bearings — Bearings containing dispersed solid lubricants

## 1 Scope

This International Standard specifies a bearing containing dispersed solid lubricants which has been used as a solid lubricant bearing.

NOTE In the solid lubricant bearing among self-lubricating bearings, there is a solid type, a coated type, an embedded type and a dispersed type which is specified by this standard.

## 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 3547-1, *Plain bearings — Wrapped bushes — Part 1: Dimensions*

ISO 3547-2, *Plain bearings — Wrapped bushes — Part 2: Test data for outside and inside diameters*

ISO 3547-3, *Plain bearings — Wrapped bushes — Part 3: Lubrication holes, grooves and indentations*

ISO 3547-4, *Plain bearings — Wrapped bushes — Part 4: Materials*

ISO 3547-5, *Plain bearings — Wrapped bushes — Part 5: Checking the outside diameter*

ISO 3547-6, *Plain bearings — Wrapped bushes — Part 6: Checking the inside diameter*

ISO 3547-7, *Plain bearings — Wrapped bushes — Part 7: Measurement of wall thickness of thin-walled bushes*



## 3 Symbols and units

See Table 1.

**Table 1 — Symbols and units**

| Symbol | Description | Unit |
|---|---|---|
| $B$ | Width of the bush | mm |
| $D_i$ | Inside diameter of the bush | mm |
| $D_o$ | Outside diameter of the bush | mm |

# 4 Characteristics

## 4.1 Structure

A bearing containing dispersed solid lubricants is made of sintered composite materials that contain solid lubricants dispersed uniformly in the metal matrix and is manufactured by powder metallurgy (see Figure 1).

This standard includes multi-layered bearings with the sintered layer on a steel backing and both seamless and wrapped bushes (see Figure 2).

Figure 3 shows a typical microstructure of the bearings containing dispersed solid lubricants. The dispersed solid lubricants in the metal matrix vary in grain size and volume.

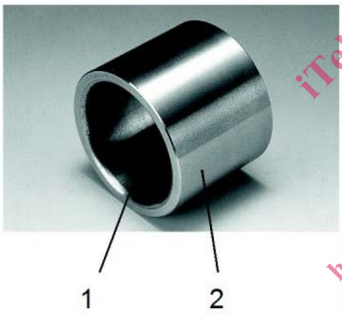
**a) seamless bush**

**(fine solid lubricants type)**

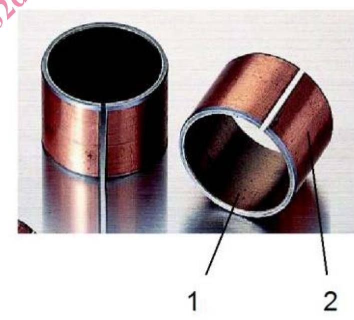
**a) seamless bush**

**(coarse solid lubricants type)**

**Figure 1 — Overview of bearings containing dispersed solid lubricants (Single-layered)**




**a) seamless bush**




**b) wrapped bush**

**Key**

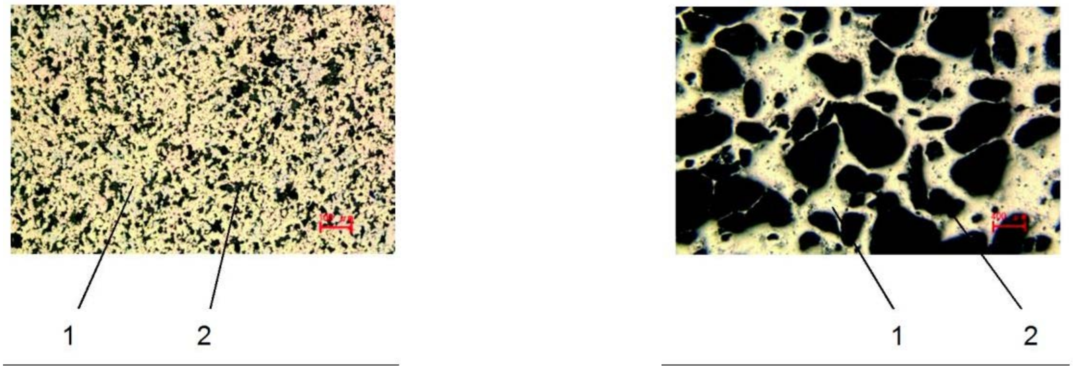
1 sintered layer

2 steel backing

**Figure 2 — Overview of bearings containing dispersed solid lubricants (Multi-layered)**






a) fine solid lubricants type

b) coarse solid lubricants type

**Key**

1 metal matrix

2 dispersed solid lubricant

**Figure 3 — Microstructure of a bearing containing dispersed solid lubricants**

## 4.2 Bearing characteristics

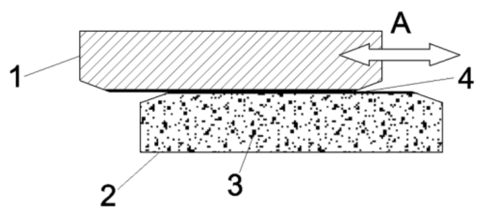
A bearing containing dispersed solid lubricants obtains its sliding performance from the self-lubricating effects of solid lubricants and the mechanical strength of metal matrix.

The sliding performance and mechanical strength vary according to the volume of solid lubricants. Higher sliding performance requires more solid lubricants, while higher mechanical strength requires less solid lubricants.

Since solid lubricants are dispersed over the entire material, the bearings are particularly suitable for extra low speed or micro-motion applications, minimising static friction to achieve smooth sliding at the start of motion.

The solid lubricants are drawn out over both surfaces from the bearing material when it slides against the mating surface, forming a solid lubricant film. As the solid lubricant film is consumed, it is replenished from the bearing material to maintain a continuous film throughout the life of the product (see Figure 4).






**Key**

1 mating member

2 metal matrix

3 dispersed solid lubricant

4 solid lubricant film

A sliding direction

**Figure 4 — Lubricating mechanism of a bearing containing dispersed solid lubricants**

### 4.3 Applicable field

The bearing can be used for rotational motion, reciprocating motion, oscillating motion and frequent start/stop cycles. The bearing is also used in such applications where no fluid lubrication can be expected because of high load and low speed operation. Bearings with appropriate materials are suited to applications with high or low temperature, liquids, gases and in vacuo.

The bearing has been developed to operate satisfactorily without oil or grease lubricants. However, if the application permits, oil or grease may be utilised to improve bearing durability, prevent dust from entering the bearing, flush out wear debris or prevent corrosion of the bearing components.

## 5 Material

### 5.1 Metal matrix

The constituent elements of the metal matrix in the bearing define the physical, chemical and mechanical properties of the bearing. The chemical composition and manufacturing methods (sintering and heat treatment) influence the bearing metal matrix properties.

Metal matrix base materials are principally copper, nickel or iron. Table 2 shows the operating temperature for the alloy types.

**Table 2 — Types of alloy and their operating temperature**

| Alloy type | Operating temperature [a]<br>°C |
|---|---|
| Copper based alloys | -200 to 450 |
| Nickel based alloys | -200 to 600 |
| Iron based alloys | 0 to 700 |
| [a] Operating temperature varies according to the composition. | |



The most commonly-used, copper-based metal matrix group is Cu-Sn, but Cu-Ni-Sn and Cu-Ni-Fe alloys offer enhanced thermal resistance and strength.

The nickel-based metal matrix group includes Ni-Cu-Fe alloys, which offer high corrosion resistance.

The iron-based metal matrix group includes Fe-Cu alloys which offer higher thermal resistance than copper-based alloys by the formation of iron oxide lubricant films. In addition there are high-heat resistant Fe-Ni-Cu alloys and stainless alloys (Fe-Cr-Ni alloys, etc.).

Metal matrix may contain small additive additions to enhance performance. The surface of metal matrix may have an additional running-in coating.

A guide for the selection of a bearing metal matrix for bearings containing dispersed solid lubricants is shown in Figure A.1 of Annex A.

### 5.2 Solid lubricant

Many types of solid lubricants are available. They are selected to suit the operating conditions because their friction performances are influenced by the operating environment. The majority of bearings incorporate graphite and molybdenum disulphide as solid lubricants. Other solid lubricants with low friction, suited to demanding environments, include tungsten disulphide, boron nitride and polytetrafluoroethylene (PTFE). Table 3 shows an outline for the operating temperatures and the atmosphere for the solid lubricants.

The size and type of solid lubricants are selected based on the operating conditions.

**Table 3 — Types of solid lubricants and their properties**

| Type | Operating temperature °C | Atmosphere | | |
|---|---|---|---|---|
| | | In air | In water | In vacuum |
| Graphite | -120 to 600 | good | applicable | poor |
| $MoS_2$ | -100 to 400 | good | poor | good |
| $WS_2$ | -180 to 600 | good | poor | good |
| BN | up to 900 [a] | good | - | - |
| PTFE | -260 to 260 | good | good | good |

[a] BN shows good performance in an oxidising atmosphere at high temperature.

## 5.3 Combination of metal matrix and solid lubricant

According to a combination of the metal matrix with the solid lubricant types, their grain size, their volume and manufacturing methods permit satisfactory bearing selection for a wide range of applications. Determination of the composition of both metal matrix and solid lubricant is a critical task.

Table 4 shows typical examples of metal matrix and solid lubricant combinations and suitable applications. Further, examples of actual applications of a bearing containing dispersed solid lubricants are shown in Table B.1 of Annex B.