

Materials

Bearing material 100Cr6

Bearing rings and bearing rolling elements are manufactured from vacuum degassed, fine-grained bearing steel 100Cr6 (1.3505). The characteristics of the steel are as follows:

hardness	60...62 HRC 650...710 HV
density	7.83 g/cm ³
specific heat capacity	0.47 kJ/(kg K)
thermal conductivity	46 W/(m K)
electric resistance coefficient	22 μΩ cm
coefficient of thermal expansion	12 · 10 ⁻⁶ /K
Young's modulus	208000 N/mm ²
elastic limit	1370 N/mm ²
tensile strength	1570 N/mm ²
breaking elongation	max. 0.5%
Poisson's ratio	0.3

Heat treatment

The bearing rings made from 100Cr6 are dimension-stable up to a service temperature of 150 °C as standard. For higher temperatures, higher-quality heat treatment is available upon request, provided all the components are designed for these higher operating temperatures.

ChromoTec

IBC high precision rolling bearings from the ChromoTec series with the prefix X have the full load carrying capacity but a very much higher resistance to corrosion.

hardness	58...60 HRC 630...690 HV
density	7.67 g/cm ³
specific heat capacity	0.50 kJ/(kg K)
thermal conductivity	14 W/(m K)
electric resistance coefficient	60 μΩ cm
coefficient of thermal expansion	10 · 10 ⁻⁶ /K
Young's modulus	213000 N/mm ²
elastic limit	2350 N/mm ²
tensile strength	2410 N/mm ²
breaking elongation	3%
Poisson's ratio	0.3

Silicon nitride Si₃N₄

The unique combination of extreme hardness, high mechanical strength, resistance to corrosion and abrasion, low thermal and electric conductivity and a low specific weight make silicon nitride the ideal material for use in rolling bearings. In addition, silicon nitride has a lower adhesion compared to steel and therefore puts less strain on the lubricant.

Even if there is initial stage and progressive damage to a rolling element, the ceramic material will in most cases retain its rolling stability.

hardness	1600 HV
density	3.24 g/cm ³
thermal conductivity	25 W/(m K)
electric resistance coefficient	10 ¹³ Ω cm
coefficient of thermal expansion	3.4 · 10 ⁻⁶ /K
Young's modulus	300000 N/mm ²
elastic limit	1050 N/mm ²
Poisson's ratio	0.27

Steels for IBC rolling bearing rings					
Prefix	Designation	Material No.	USA	Japan	Hardness (HRC)
-	100Cr6	1.3505	SAE52100	SUJ2	60-62
X	X 30 CrMoN 15 I	1.4108	AMS5898		58-60

Table 9.1: Overview of rolling bearing steels



Cage characteristics and features

Bearing cages have a whole range of functions to fulfil in a rolling bearing:

- They keep the rolling elements at a distance, prevent them from touching each other and thereby reduce friction and resulting heat.
- They ensure that the rolling elements are evenly distributed; this guarantees quiet running.
- They guide the rolling elements in the unloaded area of a rolling bearing; this improves the rolling conditions, which in turn prevents detrimental slipping from occurring.

Chemical effects also have to be taken into account. The lubricant and its additives, ageing products that result from lubricant and additives as well as solvents and cooling agents put a strain on the cage materials. That is why widely differing cage materials are available.

Materials for bearing cages

Many cage variations are available, depending on the type of rolling bearing and its size. If bearings are used with high operating temperatures or in problematic operating conditions the use of an alternative type of cage is advisable. Please contact us if you need a special cage for your application.

T	fabric reinforced phenolic resin cage (standard)
P	pocket type nylon cage, PA6.6, fibre-glass reinforced
M	brass cage
PY	PPS cage
K	PEEK cage, fibre-glass reinforced
S	high-grade steel cage
G	PTFE cage

The first two cage options mentioned below are the best suited for use in machine tools. Due to their special characteristics, they cover a broad range of applications.

Fabric reinforced phenolic resin (T)

The low specific weight of this material, a low friction coefficient and its high strength make it suitable for the highest speeds with very low heat generation. The maximum operating temperature is limited to a permanent operation temperature of 100 °C.

Polyamide (P)

Polyamide is also used in a fibre-glass reinforced state and combines low weight with good absorption and good sliding properties. This variant is characterised by a shortened running-in time for grease lubrication.

Brass (M)

Solid cages made of brass are very durable and operate reliably under the most difficult conditions. They are suited to rolling bearings with a higher heat stabilisation that are used with high temperatures.

PPS (Polyphenylene sulfide) (PY)

Cages made of PPS are resistant to most acidic, alkaline and organic solutions. They have a higher strength, toughness and fatigue strength than traditional polyamide cage-materials. They are temperature resistant up to 220 °C.

PEEK (Polyether ether ketone) (K)

This material in a fibre-glass reinforced state is suited to operating temperatures of up to 200 °C. If the temperature range is limited to 150 °C, very high rotational speeds are attainable.

High-grade steel (S)

The outstanding characteristic of this material is its chemical resistance. High-grade steel cages are suited to rolling bearings with a higher heat stabilisation too.

PTFE (Polytetrafluoroethylene) (G)

This synthetic material is chemically and thermally highly resistant and has a very small friction coefficient. This cage material is not suitable for the highest speeds, however. Thermal endurance reaches 250 °C.

Synthetic material cages made of fibre-glass reinforced polyamide PA6.6 are suitable for operating temperatures between -20 °C and +120 °C; it should be noted that the lubricant used has a strong impact on service life. If you are planning to use synthetic lubricating greases and oils with EP additives the chemical resistance of the cage material should be checked in advance. In conditions accompanied by higher temperatures, the life time of a synthetic cage may also be reduced if aged oils are used or if the additives in the oil have aged. Oil change periods should therefore be strictly adhered to. Rolling bearings should not be used with a polyamide cage if they operate near ammonia or Freon acting as cooling agents.



Materials for seals

Sealed high precision angular contact ball bearings have the advantage of being both very reliable and safe. The seal protects the rolling bearing from contamination and thereby extends both the life time of the lubricant and the overall system.

Various materials are used, depending on the operating conditions. The standard material acrylonitrile butadiene caoutchouc (NBR) has absolutely proved its worth in practice. This material has a very good resistance to the following media:

- most mineral oils and lubricating greases based on mineral oils;
- regular-grade petrol, diesel fuel and light fuel oil;
- animal and vegetable oils and fats;
- water, as well as emulsions of water and the above mentioned media.

The application temperature range lies between $-40\text{ }^{\circ}\text{C}$ and $+100\text{ }^{\circ}\text{C}$. Higher temperatures of up to $120\text{ }^{\circ}\text{C}$ may be realised for short periods.

For applications that have special requirements with regard to the material of the seal, please contact our department for technical applications. We have used seals made from various alternative materials in the past, e.g. fluoroelastomers (FKM), polyacrylates (ACM) and polytetrafluoroethylene (PTFE).

