

# Ceramic ball bearings

The material characteristics of ceramic ball bearings allow them to be used with lubrication or dry-running. This makes them ideal for use in hygienic areas, the food and pharmaceutical industries as well as medical, clean room and vacuum environments. The open construction allows ceramic bearings to be easily cleaned and they are insensitive to high-pressure cleaning. Their special properties allow them to be used in autoclaves without special maintenance or maintenance intervals.

## Ceramic ball bearings have a number of advantages over metal bearings:

- Exceptionally smooth running characteristics due to very low friction
- Little or no maintenance (possible use with lubrication, minimal lubrication or dry-running)
- Lower wear leading to a longer service life
- Up to 60% lighter
- Very high chemical resistance
- Resistant to corrosion and pitting
- Insensitive to moisture
- Extremely hard and rigid
- Non-magnetic, no interaction with magnetic fields
- High temperature resistance, up to 1600°C, depending on version

Due to its special properties the preferred material for ceramic bearings is silicon nitride (Si3N4) which is light, extremely strong and wear-resistant. The inexpensive alternative is zirconium oxide (ZrO2). Moreover, its thermal expansion is similar to that of steel and it is exceptionally well-suited for use in hybrid bearings.

| Chemical Resistance               | Si3N4 | ZrO2 | X105CrMo17 (AISI 440C) |
|-----------------------------------|-------|------|------------------------|
| Hydrochloric acid HCl (dil.)      | +     | +    | -                      |
| Hydrochloric acid HCl (conc.)     | +     | (+)  | -                      |
| Nitric acid HNO3 (dil.)           | +     | +    | +                      |
| Nitric acid HNO3 (conc.)          | +     | (+)  | +                      |
| Sulphuric acid H2SO4 (dil.)       | +     | +    | -                      |
| Sulphuric acid H2SO4 (conc.)      | +     | (+)  | -                      |
| Phosphoric acid H3PO4             | +     | +    | -                      |
| Hydrofluoric acid HF              | -     | -    | -                      |
| Sodium hydroxide solutions NaOH   | +     | +    | +                      |
| Potassium hydroxide solutions KOH | +     | +    | +                      |
| Sodium chloride NaCl              | +     | +    | -                      |
| Potassium chloride KCl            | +     | +    | -                      |
| Copper chloride CuCl2             | +     | +    | -                      |

Chemical resistance of ceramic material compared to ball bearings made from high-quality martensitic stainless steel (AISI 440C)

| Material properties              |                              | Si3N4            | ZrO2            | 100Cr6                             |
|----------------------------------|------------------------------|------------------|-----------------|------------------------------------|
| Density                          | $\rho$ g/cm <sup>3</sup>     | 3,2              | 5,9-6,4         | 7,85                               |
| Hardness                         | HV10 N/mm <sup>2</sup>       | > 1700           | > 1300          | 700                                |
| Modulus of elasticity            | E GPa                        | 300              | 205             | 210                                |
| Coefficient of thermal expansion | $\alpha$ 10 <sup>-6</sup> /K | 3,2              | 10,2            | 11,5                               |
| Flexural strength                | $\sigma_B$ N/mm <sup>2</sup> | > 800            | 1000-1500       | > 2500                             |
| Fracture toughness               | IC MPa m <sup>1/2</sup>      | 8                | 8-12            | > 20                               |
| Thermal conductivity             | $\kappa\lambda$ W/m · K      | 30-35            | 2               | 40-45                              |
| Specific elec. resistance        | $\rho$ $\Omega$ m            | 10 <sup>12</sup> | 10 <sup>9</sup> | 10 <sup>-7</sup> -10 <sup>-6</sup> |
| Grain size                       | d $\mu$ m                    | < 1              | < 1             | -                                  |

