



CERAMIC SLIDING BEARINGS FOR MAGNETIC MIXERS

www.kyocera-fineceramics.eu

CERAMIC SLIDING BEARINGS

In the production of pharmaceuticals, several substances such as powders and liquids are mixed in aseptic equipment. Hence, complete sterility of all mechanical components in such equipment is required. In this type of application magnetic stirrers are commonly used where there is **no mechanical connection** between the motor and the rotor of the stirrer, and the torque is transmitted by means of a magnetic field. Magnetic drive mixers without mechanical seals or stuffing boxes **minimize the risk of contamination** of the final product.

Key components of magnetic mixers are **ceramic sliding bearings** which are in direct contact with the mixed product and additionally are exposed to temperature changes and cleaning chemicals.

Usually the male bearing is made of zirconium oxide and the female bearing is made of silicon carbide. The static, robust male bearing is attached to the vessel's tank plate and the rotating female bearing is integrated and sealed with the mixing head. The inner bearing made of zirconium oxide has increased resistance to impacts and damage from sudden rotor settling or during assembly/disassembly of the mixer. The outer bearing made of silicon carbide provides **superior abrasion resistance and low surface roughness.**

The hardness of both materials ensures **long lifetime and no particle shedding.** The sterility and inertia of the ceramics ensures maximum cleanliness in the tank. Ceramic bearings do not require additional lubrication. The resistance to temperature variations of both ceramics allows the use of **cleaning and sterilization in place (CIP/SIP).**

When buying bearings from Kyocera, both ceramic materials come from a single source, which guarantees full material traceability. Both materials are perfectly matched to each other with strict tolerances and surface requirements. Thanks to our extensive mechanical machining facility we can achieve high quality surfaces with minimal friction in the operating mode and with **reduced breakage risk in dry run conditions.** For various designs and mounting solutions, we can produce ceramic threads or shrink fit ceramic in metal housings. For many years our bearings have been supplied to the largest manufacturers of magnetic mixers for critical pharmaceutical applications. All of our materials employed for magnetic mixers **comply with applicable FDA requirements and USP Class VI classifications.**

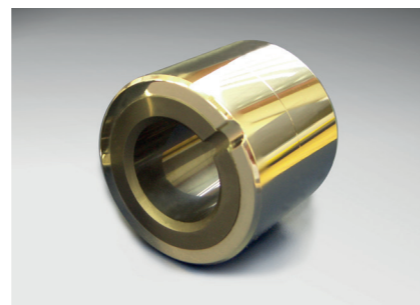
Kyocera supports you in finding the best ceramic solution for your mixing needs.



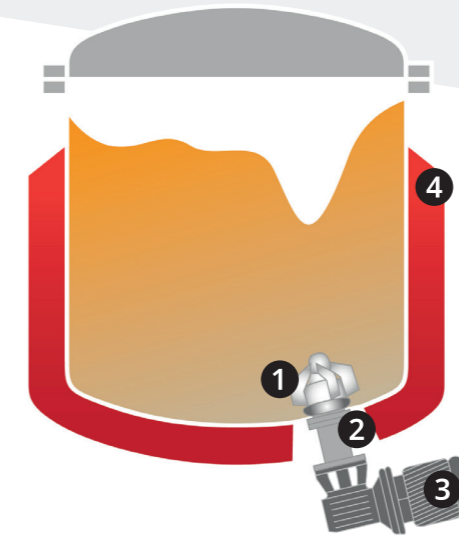
Female bearing made of silicon carbide StarCeram® SSiC, male bearing made of zirconium oxide FZM



Male bearing made of silicon carbide StarCeram® SSiC



Shrink fit ceramic in metal housing



- 1 Impeller magnet
- 2 Magnetic drive assembly
- 3 Geared motor
- 4 Vessel

Combination of zirconium oxide FZM and silicon carbide StarCeram® S

- ▶ Zirconium oxide (FZM) is used because of high impact resistance (high flexibility/low E-Modulus)
- ▶ Silicon carbide (SSiC) is used because of hardness and wear resistance

Why ceramics?

Ceramic bearings are one of the most critical parts in the mixer:

- ▶ Direct contact with the high value product (product lubricated)
- ▶ Exposure to cleaning chemicals and temperature cycling

Main advantages

- ▶ Eliminates risk of contamination from mechanical wear debris
- ▶ Biocompatibility: complying with FDA rules and USP Class VI certification required for pharmaceutical and biotechnology industries
- ▶ Good thermo shock resistance CIP/SIP possible (clean in place / sterilization in place)
- ▶ Perfect finish and surface quality Ra < 0,5 µm
- ▶ No product residue or bacterial growth
- ▶ Low shear forces (particle generation below detectable levels)
- ▶ Minimalized drag force
- ▶ Emergency dry run possible
- ▶ Tight tolerances for perfect coupling between bearings (up to 5 µm)
- ▶ Simple design eliminates entrapments of product (no product stagnation between bearing surfaces)
- ▶ Easy maintenance - ceramic bearing parts can be replaced by users on site

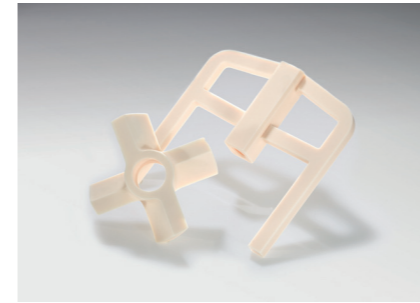
Our strengths

- ▶ Long term proven quality in application
- ▶ One source for both ceramic materials
- ▶ High precision grinding technologies
- ▶ Metal-ceramic joints or threads in ceramics possible

Material properties

Properties	Unit	FZM	StarCeram® S	Metal
Main components	-	ZrO ₂ , MgO	SiC	Stainless steel
Properties of microstructure				
Density	g/cm ³	≥ 5.70	3.16	7.8
Open porosity	Vol. %	0	0	0
Water absorption	%	0	0	-
Average crystal size	µm	50	-	-
Mechanical properties				
Hardness (HV1)	GPa	10.7	23	7.2 (HV10)
Compressive strength	MPa	2000	> 2500	1700
Bending strength σ_m	MPa	500 (DIN EN 843-1)	450	500
Modulus of elasticity (E-modulus)	GPa	185 (static)	440	210
Poisson ratio	-	0.3	0.17	0.3
Fracture toughness K_{Ic}	MPa*m ^{0.5}	6.3 (SEVNB)	2-3	-
Thermal properties				
Max. operating temperature	°C	900	1400	120-280
Specific heat 20 °C	J/(kg*K)	400	670	502
Thermal conductivity	W/(m*K)	3	200	45
Thermal expansion coefficient 20-300 °C	10 ⁻⁶ /K	10.6	4.4	12
Electrical properties				
Specific electrical resistance 20 °C	Ω·cm	10 ¹⁰	10 ⁸	10 ⁻⁶
Typical colour	-	yellow	black	-

Characteristic values may vary depending on shape of products and service conditions.



Stirrers made of alumina



Male bearing assembly on tank plate

Near net shape forming method (F-Molding)

For stirrers elements Kyocera can produce complex shape elements using new near net shape forming method (F-Molding). In this method elements are casted directly to a parts shape without need of green machining before sintering. This way machining costs are reduced in comparison to other ceramic production methods.

Advantages

- ▶ Complex shape: products with **complex shapes** that cannot be machined
- ▶ Cost saving by **reducing waste of raw materials** (vs. cold isostatic pressing)
- ▶ Cost saving through **less processing** (vs. cold isostatic pressing)
- ▶ **Saving initial cost**: an economical forming die (vs. injection / press forming)

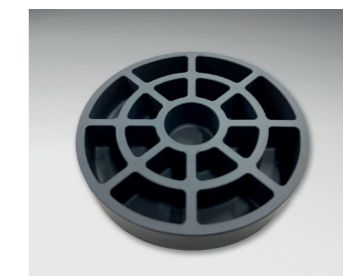
Examples

F-Molding method creates more freedom in design for manufacturing.

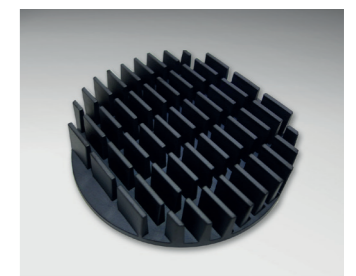
Materials: Zirconia, Silicon Nitride, Silicon Carbide, Cordierite



Zirconia (Z206N)



Silicon Nitride (SN240)



About Kyocera

Headquartered in Kyoto, Japan, Kyocera is one of the world leaders in the manufacturing of ceramic components and products, with an extensive range of applications. Kyocera now provides over 200 kinds of ceramic materials including oxide, non-oxide and some special composites, with cutting edge technology and services designed to meet the individual needs. Our long-standing experience in the field of ceramics is applied in the production of very precise, high quality products used in multiple fields.

With the acquisition of two finceramics manufacturing assets in 2019, Kyocera is able to respond quickly to clients in Europe, satisfying the growing market demand for finceramic components. Kyocera provides solutions expertise in the field of high-performance ceramics from engineering through rapid prototyping to serial production, from very precise components to complex shaped parts of various sizes and dimensions for challenging applications. Kyocera provides system components for advanced technology applications in fields of electronic and sensor technology, machinery and equipment, laboratory and analytics, medical treatment and semiconductor industry.

The ceramic expert with material expertise of more than 60 years has supplied the bearings for many years to the largest manufacturers of magnetic mixers for essential pharmaceutical and food applications.



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