Pumps and gaskets fine-tuned for maximum performance

Handling aggressive chemicals or hot water would be impossible without tailored high-performance materials. This is the only way to provide effective wear protection for pump bearings and gasket systems. Heiko Schulz of ESK Ceramics GmbH & Co. KG explains how components made of EKasic® silicon carbide (SiC) offer extreme reliability and environmental safety for almost any application — especially true of handling critical process fluids.

In many industrial processes, pumps and gaskets are the invisible backbone of production operations. If a leak occurs, the resulting downtime will inevitably be felt in the cost balance. There is also a serious safety hazard associated with a leak of, for example, aggressive media or toxic organic substances.

To minimize these risks, modern high-performance materials are preferably used in modern plant engineering.

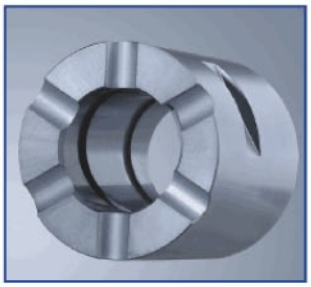

Figure 1. EKasic® sliding bearing with lubrication grooves.

Figure 2. EKasic® shaft for magnetically driven pumps.

Trump cards

In many critical applications, the use of silicon carbide (SiC) can increase the application limits of highly loaded parts by orders of magnitude. Thanks to its hardness and high melting point, SiC has gained importance as an abrasive and a component in refractories. Moreover, as an engineering ceramic, SiC has become established as a high-performance material, and so the chemical and process engineering industries can benefit not in the least from its many important properties. They include:

- good chemical resistance
- low density
- high stiffness
- high hardness
- high wear resistance
- outstanding thermal conductivity
- good thermal and thermal shock resistance.

For example, SiC has benefits as a material for axial and radial bearings in chemical pumps. The same applies to SiC shaft casings, which effectively protect the rotating shafts against wear, since the material is so hard that it is not even eroded by abrasive particles in the fluid being pumped. Silicon carbide is also usually the preferred material for mechanical seals – harder than quartz and corundum. Only diamond is harder. All the components mentioned above as typical examples benefit from the high thermal conductivity of silicon carbide, which is significantly above that of stainless steel.

EKasic® F from ESK Ceramics GmbH & Co. KG of Kempten, South Germany, combines all these specific advantages. The company now has the expertise to offer SiC grades tailored to its customers' needs. Consequently, silicon carbide grades of the EKasic® family are also not 'off the peg' products. ESK rather offers custom-made materials that are optimized to its customers' different applications and specifications.

EKasic® F

EKasic® F is the all-rounder in this family of materials. With a grain size of about 5 µm and a strength of 400 MPa, the fine-grain EKasic® F (F stands for fine grain) is a highly versatile engineering material that can also be readily used to make difficult components. The range of applications extends from mechanical seals and sliding bearings to valves and nozzles. Its high-temperature resistance, together with good thermal conductivity, makes it ideal for use in heat exchangers while withstanding the harsh conditions in chemical plants.

"Hot water is among the most aggressive media in chemical process engineering."

Plant operators have also come to appreciate the high corrosion resistance of EKasic® F in combination with outstanding thermal shock resistance. By that is meant the sudden shock change in the temperature of a material or work piece that often occurs during cooling or heating processes in refineries. With many materials, a severe thermal shock can cause work pieces to fail if the mechanical stresses induced in the material exceed a critical value.

Hot water

Hot water is among the most aggressive media in chemical process engineering. That does not mean the liquid boiling at 100°C at normal pressure, but rather water close to its critical point, which, at high pressures, can easily reach a temperature of 300°C. At these conditions, water has entirely different properties and is extremely corrosive to many materials. For example, hot water oxidizes conventional SiC at its surface to form silicon dioxide (SiO_2).

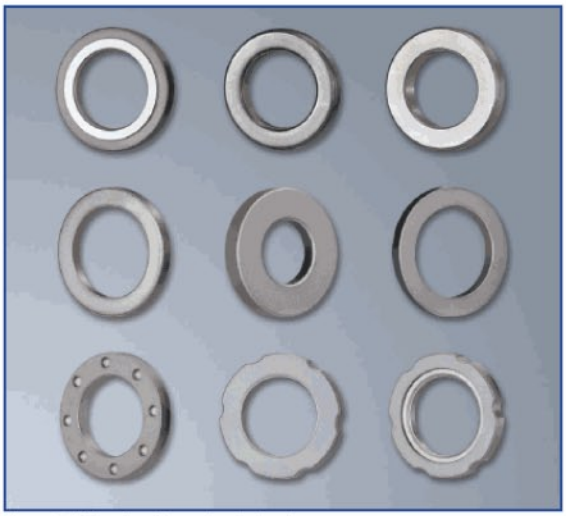

Figure 3. Sliding rings for mechanical seals.

Figure 4. Ball valve in EKasic®.

Since in sealless pumps, the bearings are directly exposed to the process fluid, a surface SiO_2 film would drastically increase the friction on the pump bearing, leading to total failure.

Research work was able to elucidate the mechanism of hot water corrosion. It was found that the grain boundary interfaces of the SiC grains represent the weak point for attack by the aggressive medium. Based on these results, another SiC material with a greatly reduced proportion of grain boundaries was developed.

The result was EKasic® C ("C" stands for 'coarse-grain') another material highlight, which, with grains up to 1.5 mm, is the coarsest grain silicon carbide that is currently commercially available. It is not only characterized by extremely good corrosion resistance, but also by excellent wear resistance. Because the grains are deeply anchored, they are also difficult to detach mechanically. EKasic® C is therefore ideal for friction parts that come into contact with highly corrosive fluids during service.

The coarse-grained matrix also has a direct influence on the surface roughness, which in turn has a positive influence on the material's tribological characteristics in wet conditions. The physical surface roughness is much better at storing residues of the lubricating medium than a very smooth surface. That approximately doubles its load-bearing capacity compared to conventional materials.

By providing EKasic® C with hot water resistance, ESK Ceramics has not only added a new material to its range but also laid the last piece in the mosaic of silicon carbide bearings' optimum property profile. This enhanced property is a major advantage for plant operators, since now they do not have to consider which fluid will be pumped when they buy a pump. There is also the user-friendly versatility of the sliding bearings, which can be fitted to sealless pumps on a modular system. This means that users do not need to stock different bearing types in their spare parts warehouse.

By realizing the outstanding properties of sintered silicon carbide materials in the form of bold designs, ESK's engineers' goal is to ensure that innovations can also be economically realized and kept under logical control. ■

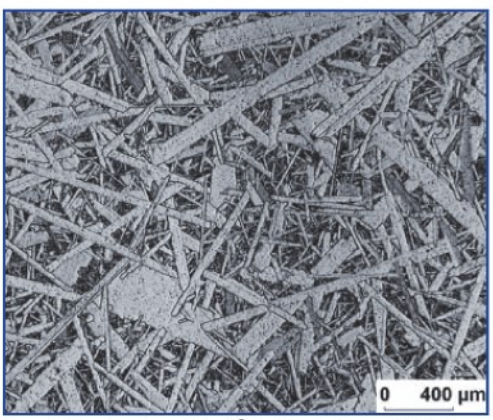

Figure 6. Microstructure of EKasic®C with grain sizes up to 1,500 µm.

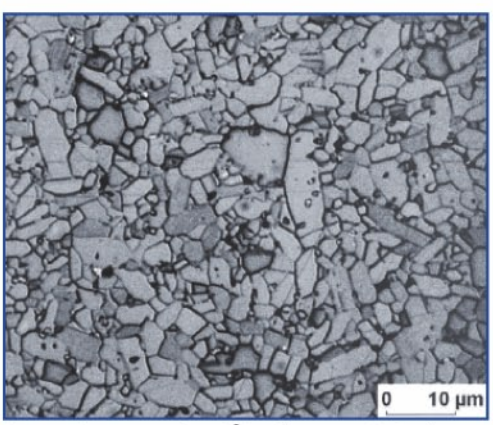

Figure 7. Microstructure of EKasic®-F with a mean grain size of < 5 µm.

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ESK Ceramics GmbH & Co KG

ESK Ceramics GmbH & Co. KG, based in Kempten, South Germany, and with a subsidiary in Bazet (France) is a manufacturer of advanced ceramic products and materials for industrial applications. ESK was founded in 1922 in Kempten. Its portfolio has 18 brands and 10 specialized materials. ESK currently has 15 patents in numerous applications. The company annually invests around 3 % of sales in R&D.

Since 2004, ESK has been a wholly owned subsidiary of Ceradyne Inc. Ceradyne is a stockmarket-listed company based in Costa Mesa, California, with over 2,230 employees at 14 sites in total. Its sales reached US$ 662 million in 2006 (around € 480 million). Ceradyne, Inc. develops, manufactures and markets advanced technical ceramic products and components to serve markets including defense, industrial and semiconductor equipment components, glassmaking furnace components, orthodontic applications, microwave tube parts and applications in diesel engines. Advanced technical ceramics, because of their lightweight, temperature resistance, hardness and other enhanced properties, can be used as a substitute for less durable metals, plastics and other ceramics.

Products, materials, industries

Ceramic

Seals and bearings, nozzles, evaporation boats, side-dams, riser tubes, thermocouple sheaths, heating tubes, break rings, electrical insulators, ceramic powders and suspensions, abrasives, pellets, plates, microreactors, heat exchangers, friction shims

Materials

Boron carbide, boron nitride, calcium hexaboride, silicon carbide, silicone nitride, titanium diboride, zirconium diboride. Functional coatings based on an electroless nickel layer in which hard particles of defined size and concentration are embedded. Depending on the function of the coating, the particles are diamond, silicon carbide or others.

Industries

Automotive, electronics, refractory industry, mechanical engineering, plant engineering and construction, metallurgy, functional coatings, fluid handling, textile industry, paper industry.