

High-Performance Ceramics for Machinery Applications



Advanced ceramics for machinery applications - combined performance of seven locations in Europe



CeramTec – customised solutions for demanding machinery applications

CeramTec is a world-leading manufacturer of advanced ceramics and is specialised in the development and manufacturing of components made from ceramic materials. With over 100 years of experience in technical ceramics, we offer our customers unique globally networked engineering and solution competence.

Our comprehensive solution portfolio covers highly customised ceramic components for different industry areas such as process engineering, equipment, machine and plant construction to ensure more precision, reliability and efficiency. Advanced ceramics significantly contribute to increasing operating life and performance capabilities of machines and systems, especially if customer specific application demands and harsh environmental conditions require individual solutions.

As an established engineering partner, CeramTec provides state-of-the-art ceramic solutions that are precisely tailored to meet customer requirements in their particular machinery application.

Our unique competencies

- Global experts in advanced ceramic materials and product development
- Dedicated R&D teams & application engineering
- Material expertise and development
- Modelling, simulation and testing capabilities
- Variety of designs, shapes, sizes, functions and complete assemblies
- Advanced manufacturing methods - from one special part to high volume production
- Vertical integration of the production process
- High performance and safety requirements

Innovative ceramic solutions for significant competitive advantages

Ceram Tec's advanced ceramic portfolio encompasses more than 10.000 different components and parts, which can be found in industrial products, machines and equipment across the globe. Ceramic solutions are critical to a multitude of applications, enabling engineers and system designers around the world to break boundaries by delivering reliable operations and long-lasting functionality even in harsh industrial environments.

When it comes to machinery applications performance and reliability are essential. Designed and manufactured in seven different locations across Europe, high-performance customised ceramic components by CeramTec combine excellent material properties and large design variety with comprehensive engineering knowhow to ensure significant competitive advantages.

Exemplary industrial applications

- Wire drawing applications
- Forming technology
- Welding technology
- Special parts and applications
- Industrial piezoceramic applications
- Textile machinery

Advanced ceramic material solutions for numerous industrial applications

Zirconium oxide (ZrO₂)

The all-purpose construction material

Unlike other ceramic materials, ZrO₂ is a material with very high resistance to crack propagation. Zirconium oxide ceramics also have very high thermal expansion and are therefore often the material of choice for joining ceramic and steel.

Material properties

- High thermal expansion ($\alpha=11 \times 10^{-6}/K$, similar to some types of steel)
- Excellent thermal insulation / low thermal conductivity (2.5 to 3 W/mK)
- Very high resistance to crack propagation, high fracture toughness (6.5 to 8 MPam^{1/2})
- Ability to conduct oxygen ions (used for the measurement of oxygen partial pressures in lambda probes)

Silicon nitride (Si₃N₄)

The ceramic material for extreme applications

Silicon nitrides are nearly as light as silicon carbide (SiC), but their microstructure gives them excellent thermal shock resistance and their high fracture toughness makes them resistant to impacts and shocks.

Material properties

- Very low density (3.21 g/cm³)
- Very high fracture toughness (7 MPam^{1/2})
- Good flexural strength (850 MPa)
- Very good thermal shock resistance: High thermal stress parameters (569 K)
- Maximum operating temperature in an oxidizing atmosphere: 1,300°C
- Maximum operating temperature in a neutral atmosphere: 1,600°C

Aluminum oxide (Al₂O₃)

The most well-known oxide ceramic material

Alumina (Al₂O₃) in its various levels of purity is used more often than any other advanced ceramic material. CeramTec offers a wide range of material types with different property profiles that can be adjusted via a targeted matrix design.

Material properties

- Very good electrical insulation (1x10¹⁴ to 1x10¹⁵ Ωcm)
- Moderate to extremely high mechanical strength (300 to 630 MPa)
- Very high compressive strength (2,000 to 4,000 MPa)
- High hardness (15 to 19 GPa)
- High corrosion and wear resistance
- Good gliding properties

Piezoceramics

High-performance material for piezo applications

With their different qualities and application options, piezoceramic materials from CeramTec are synonymous with premium efficiency and maximum reliability in the world of sensors and transducers.

Material properties

- Piezoceramics for power transducers withstand high electrical driving voltages and intense mechanical (pressure) loads and are characterized by:
- Low dielectric loss
 - Permittivity in between 900 and 1400
 - High mechanical quality factor in between 500 and 2000
 - High Curie temperature
 - High coercive field strength



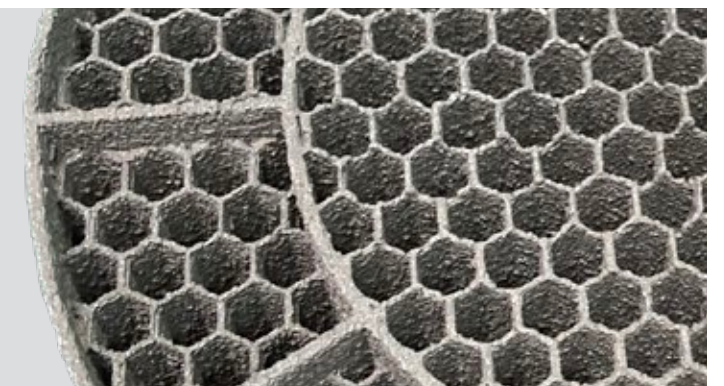
ROCAR 3D printing

Design freedom meets optimum material properties

CeramTec's 3D printing of silicon carbide is a real game changer in the world of advanced ceramic solutions. This new technology allows us maximum design variety combined with time and cost savings alongside optimal product quality. CeramTec's additive manufacturing specialists draw on their comprehensive expertise in ceramics to support you in the implementation of your projects. From the evaluation of data to the optimization of production – from single-batch customization to small-batch production.

3D printing process advantages:

- Print directly from CAD data
- No tools required
- Cavities and undercuts possible
- Short production lead and tooling times
- Maximum flexibility
- Digitalization of existing components possible
- Simultaneous production on one 3D printer



Outstanding performance made by the wire drawing experts

Increased wire quality and process reliability

Machines and wires are subject to extremely powerful forces whenever wire is drawn under full tension on the rollers and drawing cones of a wire drawing machine. The surfaces of the tools used must be perfectly adapted to the wire's requirements in order to ensure that the surface of the wire does not suffer any permanent damage. The tribological requirements for wire drawing tools demand surfaces with a high contact area and optimum surface roughness.

CeramTec is constantly developing and optimizing the surfaces of the ceramic drawing tools. This has enabled the precise definition of the particle size of the ceramic materials used as this is essential for the surface quality and roughness that can be achieved in the drawing tools.

Exemplary wire drawing ceramic components

- Ready-to-install ceramic rollers and drawing cones
- Forming rings and large components with a diameter up to 485 mm
- Ceramic rollers and guide elements



Materials

- Aluminium oxide
- Silicon nitride
- Zirconium oxide



Your CeramTec benefits

- More than 60 years of tradition, experience and technical process know how in the wire drawing business
- Ability to meet customer specific wire-drawing application demands
- Long service life & high wear resistance in harsh environments
- Low wire breakage risk due to high surface quality
- High wire quality for longer machine service life

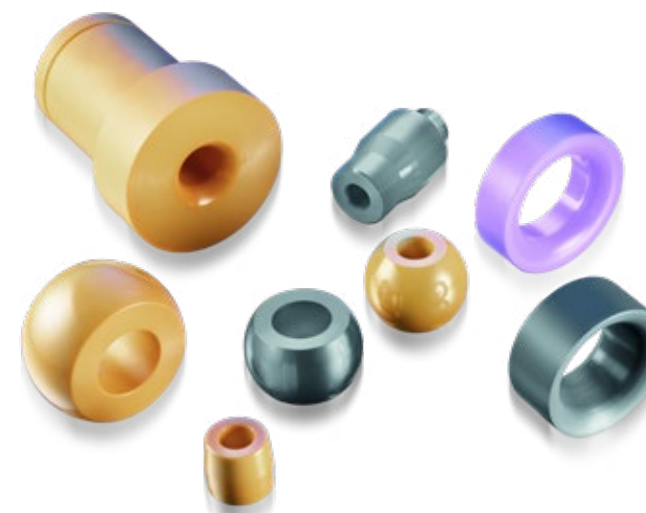
Ceramic components for tube forming applications

Designed to increase forming tools performance and extend service life

Ceramic forming tools are characterized by their uniform grain-size distribution, optimum surface roughness, superior fracture toughness and low build-up for performance that improves dimensional accuracy and vastly extends service life. The forces used in tube forming – such as drawing, bending or widening – also have an impact on the forming tools used and often push them to the limits of their performance capabilities. Tube forming ceramic tools are extremely resistant to these mechanical and thermal stresses.

Materials

- Aluminium oxide
- Silicon nitride
- Zirconium oxide



Exemplary products for drawing,
bending or widening applications

CeramTec's product advantages

- High wear resistance
- High chemical & thermal resistance
- Improved surface quality and dimensional accuracy
- No cold welds due to low diffusion and adhesion of the materials
- Reduced plastic deformation due to hot hardness and temperature strength



Silicon nitride ceramic solutions for minimized welding process wear and extended service life

CeramTec has developed the ideal silicon nitride ceramic for use in the welding process. The outcome: welding process components featuring remarkable hardness and wear resistance, and very high temperature and chemical resistance. They vastly extend service life, reduce overall retooling times, extend machine running times and enhance end-product quality.

Material advantages

- High wear resistance
- High corrosion resistance
- High temperature resistance
- High compressive strength
- No cold welding in comparison to steel
- Low weld spatter adhesion
- High thermal shock resistance



Exemplary products for welding technology

Tailored advanced ceramic solutions for special applications

Where material properties meet application know how

CeramTec develops and delivers custom-tailored high-performance ceramic solutions everywhere conventional equipment, systems and mechanical engineering materials reach their limits. Their high wear, temperature and corrosion resistance make it possible to realise completely new applications and further optimise existing systems. As a pioneer in the field of advanced ceramics, we are constantly expanding the application and development potential of these materials to meet individual customer demands.

Your CeramTec benefits

- Excellent material properties of alumina, zirconium oxide, silicon carbide, silicon nitride and mixed/dispersion ceramics in comparison to other conventional materials
- Significant competitive advantages with ceramic components to withstand toughest environmental conditions
- Highly customised and application specific design and construction to meet individual mechanical engineering requirements
- Unique R&D and 3D capabilities to evolve from generic recommendation to functional & application oriented product solutions



Exemplary custom specific products

Piezoceramic solutions for ultrasound welding and cleaning applications

Experience comprehensive piezoceramic knowhow

CeramTec has decades of experience in the manufacture of piezoelectric ceramic components, sensors and transducers for the industrial equipment market.

Many original equipment manufacturers already benefit from CeramTec's precision-machined piezoceramic parts used in high-power industrial ultrasonic applications such as cleaning or welding. We constantly partner with our customers to develop tailored solutions for specific industrial needs. Using our comprehensive design expertise and specific manufacturing capabilities of three production sites, we are well equipped to provide excellent piezoceramic components within tight specifications in whatever quantity is required. We offer high volume, highly automated production with integrated 100 % In-Line inspection as well as craftsmanship production of special components with complex shapes in low volumes.

Your CeramTec benefits

- Long-lasting tradition, experience & expertise in terms of consulting, engineering and manufacturing of industrial piezoceramic applications
- Best product quality for constant wave generation resulting in steady performance of the piezo component due to:
 - High-end surface finishing for improved mechanical coupling
 - Very good contact area for more intensive vibration
- Excellent material properties combined with extensive piezoceramic solution knowhow to meet the challenges of demanding applications, e.g. eMobility



Best-in-class piezoceramics for power transducers



Advanced ceramic components for textile machinery applications

Combining excellent knowledge of ceramic materials with expertise in ceramic design and surface finishing has helped establish CeramTec as one of the leading suppliers of advanced ceramic components for the textile machinery industry.

With its extensive material range and continuously growing production expertise in the field of ceramic components for textile processing, CeramTec offers a comprehensive line of products for textile producers and textile machinery manufacturers such as friction discs, thread guides, navels and cutters.



Exemplary products for textile machinery applications

High-performance ceramic solutions above and beyond machinery applications

Visit www.ceramtec-industrial.com to learn more about advanced ceramic solutions in the area of:

- Automotive, mobility & eMobility
- Cutting tools
- Electronics
- Measurement & sensors
- Medical equipment
- Pumps, valves & Seals



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