

Zirconia (ZrO₂)

High-toughness ceramic for precision wear parts under contact stress.

Best suited for: Precision shafts, sleeves, plungers, valve parts, rollers and components requiring toughness and close tolerance.



Engineering Positioning

Zirconia is valued for fracture toughness and resistance to crack propagation. It is a strong candidate for small precision parts where repeated contact stress, edge loading or impact makes alumina too fragile.

Typical Material Properties

Property	Typical engineering reference
Typical service temperature	800-1000 C, stabilized grade dependent
Hardness	11-13 GPa typical
Flexural strength	800-1200 MPa typical
Fracture toughness	6-10 MPa m ^{0.5} typical
Thermal conductivity	2-3 W/m-K typical
Key behavior	High toughness, high strength and strong resistance to crack growth

Values are typical reference ranges. Final data depends on grade, forming route, sintering process, geometry and test method.

Practical Application Scenarios

- Precision shafts, sleeves, guide rollers and mechanical positioning parts.
- Valve balls, valve seats, plungers and metering components under high contact stress.
- Wear components requiring tight tolerance, smooth surface finish and mechanical durability.
- Small components where shock, edge load or assembly stress increases fracture risk.

Selection Notes for Engineers

- Use zirconia when toughness and crack resistance matter more than thermal conductivity or very high-temperature capability.
- Confirm operating temperature because zirconia is not the first choice for continuous ultra-high-temperature service.
- For sliding parts, specify load, speed, lubricant or medium, mating surface and finish requirement.

Zirconia (ZrO₂) - Cost and Application Review

The lowest unit price is not always the lowest operating cost. For severe-duty ceramic components, cost should be evaluated by service life, downtime, contamination risk, replacement labor and process stability.

Example Lifecycle Cost-Saving Model

Item	Illustrative scenario
Current solution	Alumina valve sleeve cracks every 10 weeks in high-contact-load service
Zirconia scenario	Zirconia sleeve reaches 30 weeks average service life
Simple model	Alumina part: USD 90; zirconia part: USD 210; downtime and service: USD 380/change
Estimated annual impact	USD 2,444 to USD 1,023, about 58% lower annual service cost in this example

This model is illustrative, not a guaranteed saving. Actual savings depend on operating conditions, design, installation, maintenance behavior and process value per hour.

Recommended Information to Share for Quotation

- Drawing, sketch, sample photo or target geometry.
- Working temperature, thermal cycle rate and atmosphere.
- Chemical medium, abrasive particles, pressure, speed and load.
- Current material, failure mode and expected service life.
- Required tolerance, surface finish, purity, quantity and delivery target.

Why Work with Freewill Material

Material selection	Recommendation based on operating conditions, not only material names.
Custom manufacturing	Ceramic and refractory components from drawings, samples or application requirements.
Technical communication	Support for engineers and procurement teams during sample, testing and volume production.
Global customer focus	English technical content, downloadable datasheets and application-oriented inquiry support.

Contact

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Ask for an expert material recommendation and include your working condition details for faster review.