



# Advanced Ceramic Solutions for the Oil & Gas Industry

Superior Technical Ceramics (STC) offers the oil and gas industry a variety of ceramic materials to meet the increasingly severe service requirements for petroleum and gas upstream processing. As conventional and unconventional wells become more extreme operating environments, with higher pressures, temperatures and extreme pH, our engineers continue to collaborate with you to find the best material solutions for your specific challenges.

## Proven Performance in Extreme Operating Environments

Technical Ceramics are well suited for challenging operating conditions due to their unique properties, which include:

**High Temperature Resistance** -- *important in oil field settings as temperatures continue to rise downhole and thermal shock can be an issue.*

**Toughness** -- *including impact and vibration resistance*

**Hardness** -- *providing wear and erosion resistance*

**Chemical Resistance** -- *to both acidic and basic environments.*

## The Cost Effective Choice

Experience in oil & gas settings has shown that technical ceramics often provide better performance than traditional materials in high temperature, corrosive, wear and chemical environments - resulting in overall cost savings for our customers.

### Downhole Tool Components

- Poppets
- Electrode Insulators
- Float Sleeve
- Artificial Lift Components
- Poppet Seats
- Seal Carriers
- Retainer Ring
- Rupture Discs
- Wear Sleeves
- Guide Plug
- Gap Sub
- Directional Drilling Components

### Wear-Resistant Product Applications

- Chokes and Valves
- Desanders
- Mechanical Seals
- Downhole Sensor Parts
- Hanger Bearings
- Hydrocyclone Liners
- Shaft Sleeves
- Downhole Wear Parts
- Pump Impellers/Liners
- Separators
- Wearplates
- Nozzles, Sandblast/Spray

### Pump Applications

- Seal Components
- Casing Rings
- Impellers
- Impeller Rings
- Artificial Lift Components
- Casings
- Mechanical Seals
- Liners
- Shafts
- Wear Plates
- Sleeves
- Suction Pipes
- Suction Side Plates

### Ceramic Plungers, Valves & Packing Applications

- Extension Rods
- Valve Seals
- Valve Seats

# Technical Ceramic Solutions for the Oil & Gas Industry

## A Broad Spectrum of Ceramic Material Solutions

We have developed deep experience in working with technical ceramics materials, including Zirconia (YTZP, MSZ, CSZ), Zirconia Toughened Alumina (ZTA), Alumina (74-99.96%) and Silicon Nitride (Si<sub>3</sub>N<sub>4</sub>). The unique attributes of each material allow our engineers to solve individual industry challenges, all while providing cost effective solutions.

Our materials will outperform steel, as well as tungsten carbide in most oilfield applications. With our ability to offer complex shapes with near net forming, ceramics are a versatile option for achieving extended product life and increased profitability.

	Property	ASTM Method	Units	Alumina			High Purity Alumina		Zirconia Toughened Alumina			Zirconia				Nitride	Carbide	Other Materials	
				AL95 95%	AL96 96%	AL98 98%	AL995 99.5%	AL9980 99.8%	ZTA-02 US Patent 8679995	ZTA-14	ZTA-20	MSZ (Magnesia Stabilized)	YTZP 2000 (Yttria Stabilized)	YTZP 4000 (Yttria Stabilized)	CSZ (Ceria Stabilized)	Silicon Nitride (Si <sub>3</sub> N <sub>4</sub> )	Silicon Carbide (SiC) Alpha	Steel	Tungsten Carbide
General	Color	--	--	Ivory	White or Purple	White	Ivory- White	Ivory	Off White	White	White	Ivory or Yellow	Ivory	Ivory	Yellow	Black	Black	Gray	Gray
	Gas Permeability	--	atms-cc/sec	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	gas tight <10 <sup>-10</sup>	Gas Tight	Gas Tight
	Density	C 20-97	g/cc	3.65	3.71	3.78	3.88	3.91	3.96	4.17	4.30	5.72	6.02	6.07	6.20	3.25	3.15	7.7-8	15
Mechanical	Hardness	Vickers 500 gm	GPa (kg/mm <sup>2</sup> )	11.5 (1175)	12.7 (1300)	12.7 (1300)	14.3 (1459)	15 (1530)	14 (1440)	14.5 (1478)	14.4 (1470)	11.7 (1200)	12.5 (1250)	12.5 (1250)	11.7 (1200)	15 (1529)	26 (2650)	--	--
	Hardness	--	R45N	79	81	81	82	86	81	82	82	78	80	80	78	83	> 90	55 (HRC)	92 (HRA)
	Fracture Toughness	Notched Beam	MPam <sup>1/2</sup>	3 - 4	4 - 5	4 - 5	4 - 5	3 - 4	5	6	6	12	10	10	12	6	4	50-80	7
	Flexural Strength (MOR)	F417-87	MPa (psi x 10 <sup>3</sup> )	310 (45)	358 (52)	393 (57)	338 (49)	379 (55)	448 (65)	586 (85)	621 (90)	620 (90)	951 (138)	1380 (200)	551 (80)	900 (130)	483 (70)	--	1550
	Tensile Strength @ RT	--	MPa (psi x 10 <sup>3</sup> )	151 (22)	200 (29)	221 (32)	172 (25)	200 (29)	259 (38)	344 (50)	350 (51)	310 (45)	550 (80)	690 (100)	337 (49)	537 (78)	241 (35)	1110	--
	Compressive Strength @ RT	--	MPa (psi x 10 <sup>3</sup> )	1827 (265)	2068 (300)	2241 (325)	2137 (310)	2240 (325)	2413 (350)	2758 (400)	2758 (400)	1862 (270)	2485 (360)	2485 (360)	2000 (290)	2500 (362)	3306 (480)	1500	5000
	Elastic Modulus	C848	GPa (psi x 10 <sup>3</sup> )	303 (44)	310 (45)	345 (50)	379 (55)	379 (55)	358 (52)	338 (49)	338 (49)	206 (29.8)	210 (30)	210 (30)	200 (29)	300 (44)	448 (65)	620	225
Poisson's Ratio	C848	--	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.28	0.30	0.30	0.25	0.28	0.17	0.29	0.21	
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10 <sup>-6</sup> /C	6.1	6.0	6.2	6.3	6.5	6.7	6.0	6.0	8.9	6.9	6.9	6.9	--	3.7	7	--
	C.T.E. 25 - 600° C	C 372-96	x 10 <sup>-6</sup> /C	7.7	7.5	7.6	7.6	8.1	8.3	7.1	7.1	10.0	10.5	10.5	10.5	2.9	4.0	12	5
	Thermal Conductivity @ RT	C 408	W/m K	19	23	29	30	30	27	24	24	3	2.2	2.2	3.5	29	150	45	100
	Max Use Temp	--	Fahrenheit (°F)	3000	3100	3100	3047	3047	2732	2730	2730	2200	932	932	1000	2552	2912	1472	1832
--		Celsius (°C)	1650	1700	1700	1675	1675	1500	1500	1500	1200	500	500	537	1400	1600	800	1000	
Electrical	Dielectric Strength (.125" Thick)	D 149-97A	V/mil	250	250	260	270	290	230	250	250	300	240	240	250	300	--	--	--
	Dielectric Constant @ 1 MHz	D 150-98	--	9.0	9.1	9.5	9.8	9.8	10.5	12.5	12.5	22.7	30.0	30.0	30.0	9.	10.2	--	--
	Dielectric Loss @ 1 MHz	D 150-98	--	0.0006	0.0004	0.0006	0.0002	< .0001	0.0003	0.0006	0.0006	0.0016	0.0010	0.0010	0.0010	--	--	--	--
	Volume Resistivity, 25°C	D 257	ohms-cm	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>13</sup>	> 1 x 10 <sup>13</sup>	> 1 x 10 <sup>13</sup>	> 1 x 10 <sup>13</sup>	> 1 x 10 <sup>14</sup>	> 1 x 10 <sup>5</sup>	10-5	<103
	Volume Resistivity, 500°C	D 1829	ohms-cm	3 x 10 <sup>9</sup>	7 x 10 <sup>9</sup>	2 x 10 <sup>9</sup>	5 x 10 <sup>10</sup>	6 x 10 <sup>10</sup>	6 x 10 <sup>10</sup>	2 x 10 <sup>9</sup>	2 x 10 <sup>9</sup>	1 x 10 <sup>7</sup>	1 x 10 <sup>6</sup>	1 x 10 <sup>6</sup>	1 x 10 <sup>6</sup>	--	--	--	<103
Chemical	Acid / Base Resistance*	--	--	●	●	●	●	●	●	●	●	●	--	--	●	●	●	●	●

\*These are general guidelines for reference only. Actual chemical resistance is dependent on the specific application environment. ● Good ● Fair ● Poor

### Alumina Provides Durability and Cost Effectiveness

Alumina materials are a cost effective alternative to other materials where hardness is required for wear and corrosion resistance. Alumina also provides high compressive strength and is an excellent electrical insulator. Alumina is often used in rupture discs, wear liners, pump plungers, hydrocyclones and electrical insulators.

### Zirconia Toughened Alumina for Greater Strength & Durability

Zirconia Toughened Alumina is an excellent choice for applications requiring greater toughness and higher strength than Alumina alone, while maintaining the corrosion resistance of Alumina. This material is used in similar applications as Alumina, but where the pressures and well conditions demand greater material strength and durability. ZTA can also be metalized and brazed, similar to Alumina, to offer companies unique possibilities when designing tooling components.

### Other Zirconia Materials Provide Extended Life Performance

The Zirconia family of materials provides impact and toughness in extreme environments that often require extended life performance. YTZP offers superior strength, MSZ excellent toughness, and CSZ is a tough material similar to MSZ but with proven chemical resistance in both extreme acidic and basic environments. Zirconia is often used in MWD/LWD tooling components, artificial lift components, and frac plug buttons.

### Silicon Nitride Provides Added Thermal Advantages

Silicon Nitride offers superior strength and thermal performance for applications that require thermal shock resistance combined with overall material strength. At a lower density than the Zirconia materials, it is a lighter weight alternative while still providing excellent strength, corrosion and wear resistance.

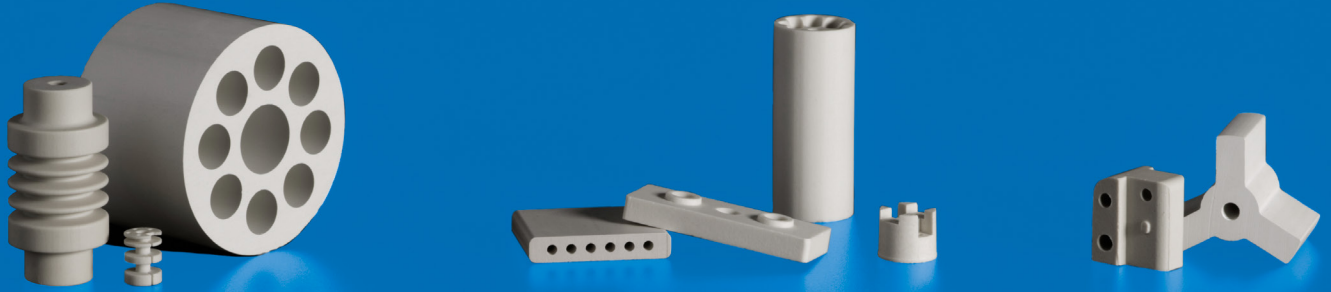


## Superior Technical Ceramics

Engineering. Partnership. Solutions.

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We specialize in providing highly technical, custom solutions for Energy Industry equipment applications. We are able to offer our customers deep expertise in the specific material properties of given ceramic materials, and matching them to specific use cases. Please contact us to discuss your unique challenges.



### Ceramic Engineering Insight



We bring 120 years of ceramics engineering experience to our customers. Our engineers' expertise provides guidance in material selection, design-to-manufacture geometry and cost effective production.

### Proven Experience in Quality Documentation Assurance



The performance of a ceramic component is dependent on the consistency and quality of its material properties. That's why we control every aspect of manufacturing; from raw material through to finished component. Powder preparation, forming, green machining, sintering and diamond grinding are all governed by the same principles of total quality management.

### Responsive Service Culture



In the larger world of ceramics, we're a mid-sized firm located in Vermont. We pride ourselves on providing direct access to our key team members and quick response times for our customers.

## Contact Us with Your Material Challenges:



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