

Ceramic Materials Summary

Oil & Gas

			ALUMINAS				ZIRCONIAS			CARBIDES				NITRIDES	
			Versatile, cost-effective combination of hardness, strength, and electrical resistivity with good wear & corrosion resistance				Tough, impact- and erosion-resistant ceramics with reliable, long-life durability.			Strong wear and corrosion resistance			Dense, wear-resistant	Superior mechanical & thermal performance, corrosion resistance	
			Wear liners, valves, insulators, dome discs, plungers				Ball check valves, bushings, fluid handling, frac plug buttons, MWD/LWD components			Seals, sleeves, rotors			Chokes, thermal spray	Bearings, sleeves, turbines	
			94-96% Aluminas		98-99.5% Aluminas		MgO Partially Stabilized Zirconia	Yttria Partially Stabilized Zirconias		Silicon Carbides (SiC)			Tungsten Carbide (WC)	Silicon Nitrides (Si ₃ N ₄)	
Properties*		Units	AD-94 nominal 94%	AD-96 nominal 96%	FG-995 nominal 98.5%	AD-995 nominal 99.5%	Dura-Z	Yttria Partially Stabilized Zirconia - Sintered	Yttria Partially Stabilized Zirconia - Hot Isostatic Pressed (HIP)	UltraSiC™ SC-30	UltraSiC™ SC-90 Plus	UltraSiC™ LP SC-52	ACI-Co6	SN102 Sinter-HIP	Steel
Density		g/cm ³	3.70	3.72	3.80	3.90	5.72	6.02 - 6.05	6.05 - 6.07	3.15	3.15	3.22	14.90	3.23	7.5 - 8.0
Gas Permeability			0	0	0	0	0	0	0 - 0.07	0	0	0	0	0	0
Color			WHITE	WHITE	WHITE	IVORY	IVORY	IVORY to WHITE	BROWN to OLIVE	BLACK	BLACK	BLACK	GRAY	GRAY	GRAY
Flexural Strength (MOR)	20 ° C	MPa (psi x 10 ³)	352 (51)	358 (52)	375 (54)	379 (55)	900 (130)	1000 - 1240	1400 - 1500	480 (70)	645	600 (87)	1550 (225)	1000	
Elastic Modulus	20 ° C	GPa (psi x 10 ⁶)	303 (44)	303 (44)	350 (51)	370 (54)	200 (29)	205 - 210	205 - 210	410 (59)	410 (59)	375 (52)	627 (91)	290	210-235 (30-34)
Poisson's Ratio	20 ° C	-	0.21	0.21	0.22	0.22	0.30	0.30	0.30	0.21	0.21	0.21	0.21	0.27	0.29
Compressive Strength	20 ° C	MPa (psi x 10 ³)	2103 (305)	2068 (300)	2500 (363)	2600 (377)	1750 (254)	2000 - 2500	2000 - 2300	3500 (507)	3750		5000 (725)	3500	1000-2000 (145-290)
Hardness	Knoop 1000 g	kg/mm ²	1175	1175	1400	1440	1200	1300	1330				1630		6.4 - 8.8 (650-900)
	Knoop 100 g	kg/mm ²								2800	2800	2800			
Tensile Strength	25 ° C	MPa (psi x 10 ³)	193 (28)	221 (32)	248 (36)	262 (38)	483 (70)								1110 (103)
Fracture Toughness	K(I c)	Mpa m ^{1/2}	4 - 5	4 - 5	4 - 5	4 - 5	11	8.5 - 10	10 - 13	4	4	6.3	> 6	6	50-80
Thermal Conductivity	20 ° C	W/m °K	22.4	24.7	27.5	30.0	2.2	2.0 - 2.2	2.0 - 2.2	150.0	150.0	80.0	100.0	18.0	35-55
Coefficient of Thermal Expansion	25-1000 ° C	1X 10 ⁻⁶ /°C	8.2	8.2	8.2	8.2	10.2	10 - 10.3	10	4.4	4.4	4.7	5.1	3.5	12
Specific Heat	100 ° C	J/kg*K	880	880	880	880	400	400	400	800	800	820	209.3	740	475
Maximum Use Temperature		°C	1700	1700	1700	1750	500	1000 - 1500	1000 - 1500	1600			1000	1000	800
Dielectric Strength	6.35mm	ac-kV/mm (ac V/mil)	8.3 (210)	8.3 (210)	8.7 (220)	8.7 (220)	9.4 (240)	9.0 (228)	9.0 (228)					8.6	
Dielectric Constant	1 MHz	25 ° C	9.1	9	9.6	9.7	28.0	29.0	29.0					8.15	
Dielectric Loss (tan delta)	1 MHz	25 ° C	0.0004	0.0002	0.0002	0.0004	0.0010	0.0010	0.0010					0.0017	
Volume Resistivity	25 ° C	ohm-cm	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹³	> 10 ¹² - 10 ¹³	> 10 ¹² - 10 ¹⁴	< 10 ⁵	< 10 ⁵		< 10 ³	> 10 ¹⁵	10 ⁻⁵
	500 ° C	ohm-cm	4 x 10 ⁹	4 x 10 ⁹	2 x 10 ¹⁰	2 x 10 ¹⁰	2 x 10 ⁵	2 x 10 ³ to 2 x 10 ⁴	2 x 10 ³	< 10 ³	< 10 ³		< 10 ³		
Impingement ¹			0.52	0.50	0.48	0.47	0.63	0.20	0.20	0.12			0.12		
Rubbing ¹				0.60			0.57	0.20	0.20						
Chemical Resistance Acids ²					●	●	●			●	●	●	●	●	●
Chemical Resistance Bases ²					●	●	●			●	●	●	●	●	●

Notes:

- Wear Resistance** - Impingement tests are run using a dry fused alumina abrasive. Rubbing tests are run using a dry 240 grit fused alumina abrasive. The indices in the chart are calculated by dividing the material volume loss by the volume loss of an AD-85 alumina control. The lower in the index, the better the wear resistance.
- Chemical Resistance** - These are general qualitative indications only. Performance is dependent on specific chemical solution, concentration, temperature, and other variables. Please request information for your specific conditions.

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Zirconias

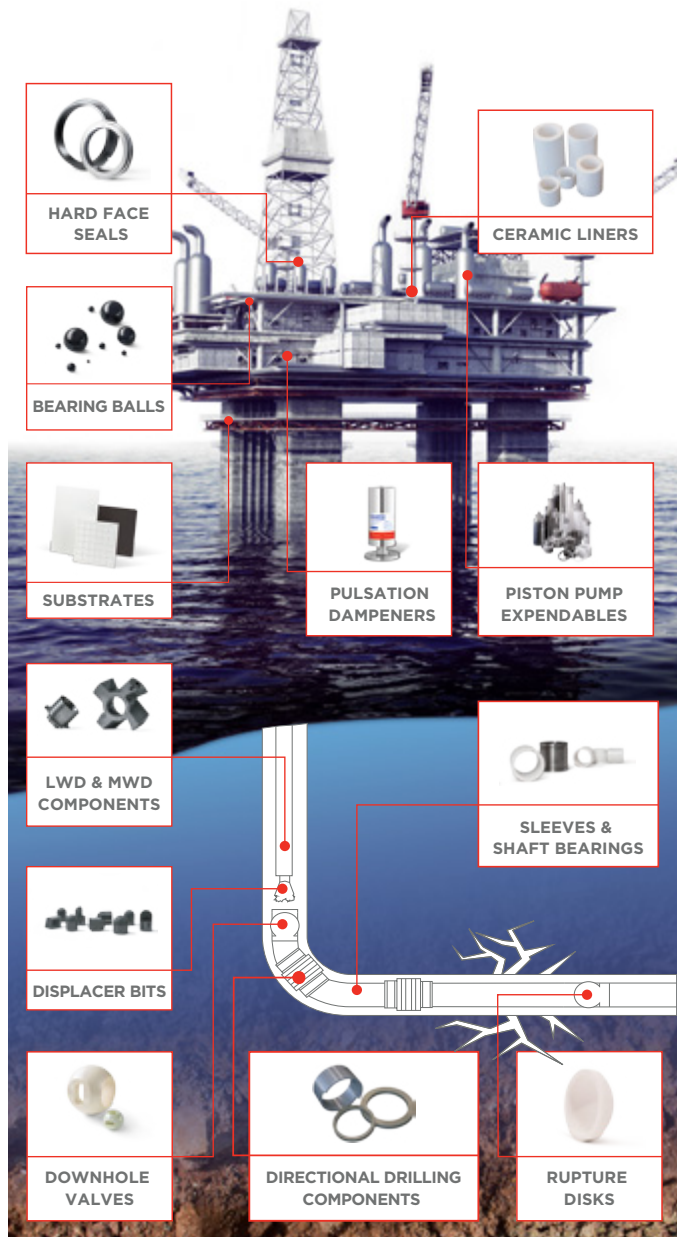


Serving Oil & Gas



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