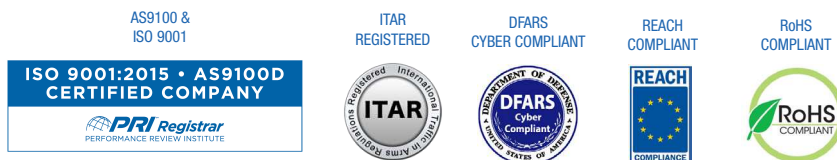




Your Experienced Partner

ECCL offers the energy industry custom ceramic solutions to promote energy efficiency, safety and superior performance in challenging and extreme environments found across the energy sector. Power distribution, renewable energy, and energy storage applications are just a few of areas within the energy market that benefit from the unique properties of ceramic materials. Excellent wear, corrosion, and electrical properties make technical ceramics an appealing option for ensuring long life components in critical energy systems.



Partnership in Energy Ceramic Application Development:

We host over 135,000 square feet of manufacturing space, which allows us to control quality in every aspect of the ceramic production process, while still maintaining industry leading levels of access to ceramics engineering talent. We have complete in-house capabilities to partner with you in engineering, tooling and manufacturing technical ceramics to your unique requirements. Our broad selection of materials offers a distinct set of properties that lend themselves for use in diverse energy applications, including:

Energy Distribution Components

- High Pressure Cable Interconnects
- Capacitors
- Vacuum Interrupters
- High Voltage Insulators
- Insulating Tubes
- Heat Exchanger Tubes
- Structural Insulators
- Convolute Standoffs
- Switch Housings
- Ceramic Seal Components
- Transmission Line Insulators

Structural Energy Components:

- Ceramic Rollers
- Foundry & Casting Components
- Ceramic Connectors
- Ceramic Insulation Cones
- Ceramics Guide Rods
- Ceramic Support Bars
- Ceramic Lead Screws
- Ceramic Nuts
- Ceramic Support Road
- Ceramic Threaded Rods
- Ceramic Baffles
- Turbine Engine Struts
- Crucibles for Piezo Processing
- Ceramic Liners
- Ceramic Insulating Tiles

Electrical Power Components:

- X-ray Tubes
- High Voltage Feedthroughs
- Cable Insulators
- Ceramic Lighting Components
- Power Switches
- Ceramic Resistors
- Standoff Insulators
- Protection Tubes
- Ceramic Bus Tiles
- Traveling Wave Tubes
- Electron Tubes
- Vacuum Switch Tubes
- Planar Capacitors
- Ceramic Thermocouple Tubes

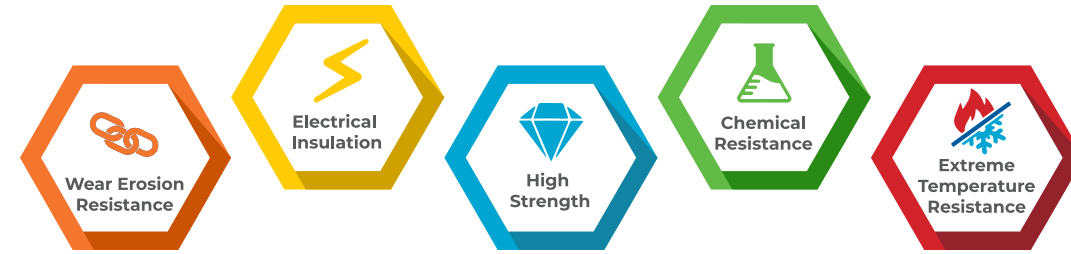
Energy Generation:

- Energy Conversion Components
- Recovery Pump Components
- Submersible Pumps
- Syngas System Components
- Hydrogen Generation Systems
- Waste Energy Capture Components
- Energy Conversion Adapters
- Hydrocarbon Processing Components
- Ceramic Rotors & Caps
- Dense Catalytic Tubes
- Membranes for Electrical Applications
- Heat Engine Insulators
- Spark Gaps Components
- Nanoporous Alumina Membranes
- Carbon Emissions Reduction

Technical Ceramic Solutions for the Energy Industry

Specialized Ceramic Material Solutions

We provide Yttria Stabilized Zirconia (YTZP), Magnesia Stabilized Zirconia (MSZ), Zirconia Toughened Alumina (ZTA) and Alumina in percentages from 74-99.96%. These materials span a wide range of material properties capable of withstanding the conditions and offering an extended useful lifetime. Ceramics are ideally suited to provide the strength, electrical, thermal and corrosion resistant properties needed in fuel cell and battery systems.



			Alumina			High Purity Alumina		Zirconia Toughened Alumina			Zirconia				Nitride	
Property			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 ₃ N ₄)	
ASTM Method			Units													
General	Color	--	--	Ivory	White or Purple	White	Ivory-White	Ivory	Off White	White	White	Ivory or Yellow	Ivory	Ivory	Yellow	Black
	Gas Permeability	--	atms-cc/sec	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰
	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
Mechanical	Hardness	Vickers 500 gm	GPa (kg/mm ²)	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)
	Hardness	--	R45N	79	81	81	82	86	81	82	82	78	80	80	78	83
	Fracture Toughness	Notched Beam	MPam ^{1/2}	3 - 4	4 - 5	4 - 5	4 - 5	3 - 4	5	6	6	12	10	10	12	6
	Flexural Strength (MOR)	F417-87	MPa (psi x 10 ³)	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)
	Tensile Strength @ RT	--	MPa (psi x 10 ³)	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)
	Compressive Strength @ RT	--	MPa (psi x 10 ³)	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)
	Elastic Modulus	C848	GPa (psi x 10 ⁶)	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)
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	
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10 ⁻⁶ /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	--
	C.T.E. 25 - 600° C	C 372-96	x 10 ⁻⁶ /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
	Thermal Conductivity @ RT	C 408	W/m K	19	23	29	30	30	27	24	24	3	2.2	2.2	3.5	29
	Max Use Temp	--	Fahrenheit (°F)	3000	3100	3100	3047	3047	2732	2730	2730	2200	932	932	1000	2552
--		Celsius (°C)	1650	1700	1700	1675	1675	1500	1500	1500	1200	500	500	537	1400	
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.
	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 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹³	> 1 x 10 ¹³	> 1 x 10 ¹³	> 1 x 10 ¹³	> 1 x 10 ¹⁴
	Volume Resistivity, 500°C	D 1829	ohms-cm	3 x 10 ⁹	7 x 10 ⁹	2 x 10 ⁹	5 x 10 ¹⁰	6 x 10 ¹⁰	6 x 10 ¹⁰	2 x 10 ⁹	2 x 10 ⁹	1 x 10 ⁷	1 x 10 ⁶	1 x 10 ⁶	1 x 10 ⁶	--
Chemical	Acid / Base Resistance*	--	--	●	●	●	●	●	●	●	●	--	--	●	●	
	*These are general guidelines for reference only. Actual chemical resistance is dependent on the specific application environment. ● Good ● Fair ● Poor															

Power & Distribution

Power & distribution systems require extreme temperature and environmentally robust materials to provide electrical insulation, high voltage resistance, all while being able to withstand a variety of operational conditions – whether outdoors or within highly specialized vacuum systems. ECCL manufactures custom alumina high voltage convolute insulators to increase life and electrical performance over porcelain materials historically used in the distribution industry.

Alternative Energy

The alternative energy industry includes several critical subsectors, including solar, wind, nuclear, fusion, biomass, and plasma gasification. Each benefit from a unique variety of ceramic powders available for meeting specific challenges. Alumina is a reliable material, available in a wide range of purities (74% - 99.96%), used in sensor components, wafer and substrate handling components, as well as in ceramic to material brazed feedthroughs and assemblies where hermeticity is necessary for safe and effective performance. Silicon nitride provides electrical insulation, lighter weight, greater lubricity for high efficiency operation.

Energy Generation & Storage

Critical components for energy generation and storage capitalizes upon the entire spectrum of ECCL materials. Hydrogen generation combines both innovative nanoporous materials, as well as high strength and high-density zirconia materials. Ceramic materials find application in dynamic energy storage and recovery systems, where other materials fail to perform.

Dedicated R&D Partnerships

ECCL can provide the ceramic engineering support necessary for your Research and Development projects, and welcome the opportunity to partner to support SBIR research. We excel at matching ceramic properties to the form, fit and function of your component needs. Our partnerships provide dedicated project teams, direct communication, and on-site technical discussions. We want to partner with you as you develop tomorrow's technology.

Engineering. Partnership. Solutions.

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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