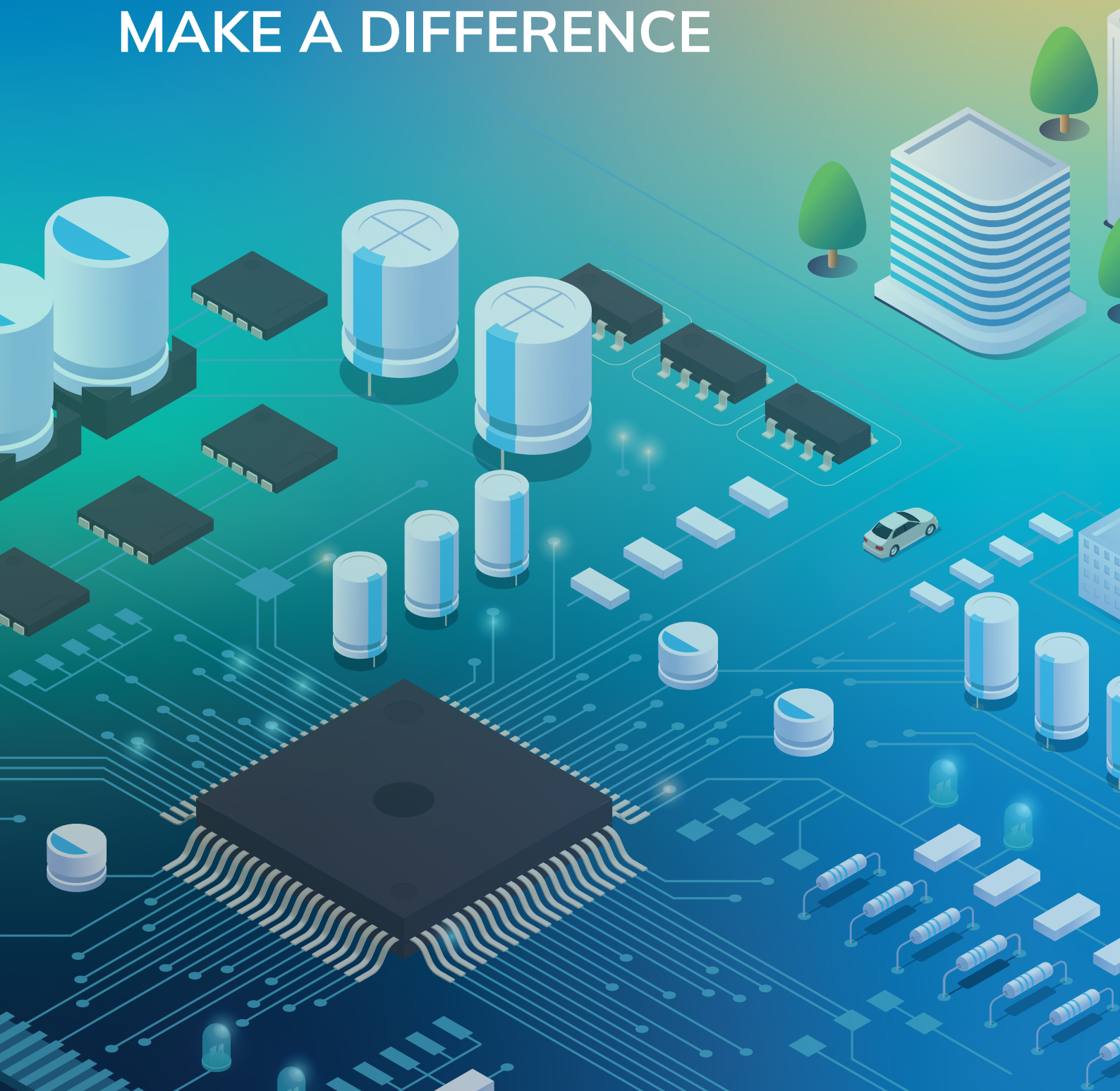


Technical CERAMICS



INDUSTRIAL
CERAMICS

CERAMIC SOLUTIONS THAT
MAKE A DIFFERENCE



FUTURE IS CERAMIC IS FUTURE



The Murugappa Group

Established in 1900, the Murugappa Group is a distinguished conglomerate headquartered in Chennai, India. With a legacy spanning over 124 years, the Group has flourished into a US\$ 9.74 billion enterprise, comprising 29 businesses across diverse sectors.

The Group's expansive portfolio includes ten companies listed on the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE). Its manufacturing capabilities extend across 99 locations and six continents.

Renowned for its strong ethical foundation and employee-centric culture, the Murugappa Group has earned immense respect. Its strategic joint ventures with international leaders such as Mitsui Sumitomo, Cargill, Foskor, Morgan PLC, and Groupe Chimique Tunisien have further solidified its reputation as one of India's fastest-growing diversified business houses.

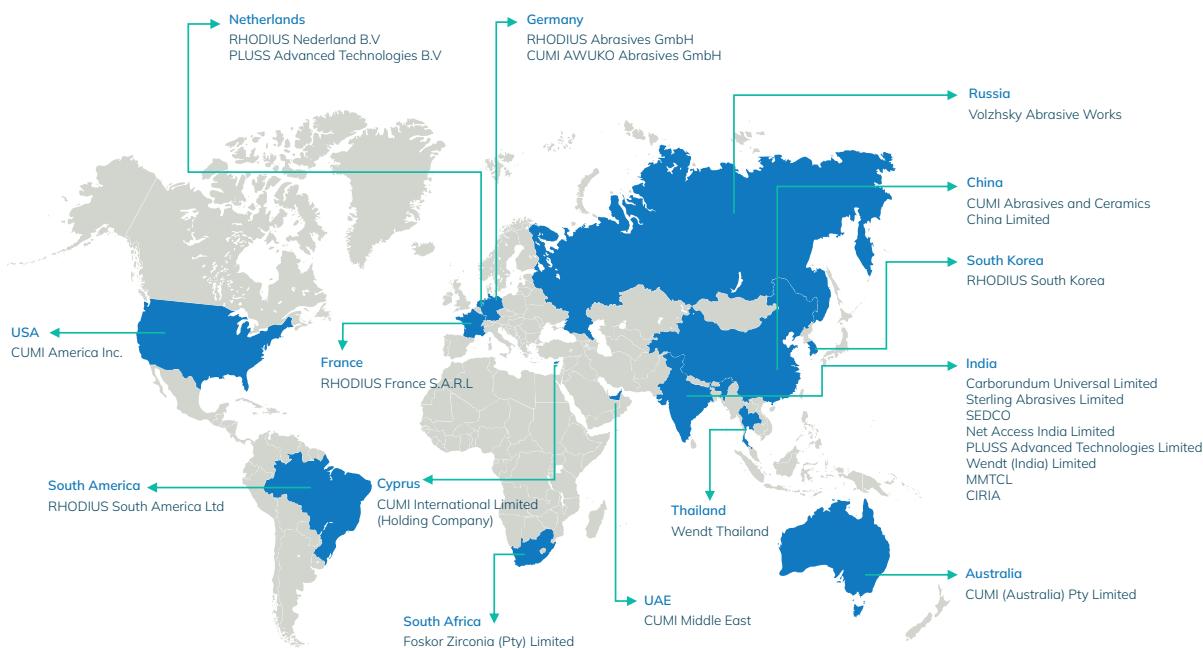
Carborundum Universal Limited (CUMI)

Founded in 1954, Carborundum Universal Limited (CUMI) is a flagship entity of the Murugappa Group and a leader in materials science engineering. CUMI has evolved into a global enterprise with products distributed across more than 40 countries and consolidated revenues of ₹46,282 million (approx. US\$550 million) in FY 2023-24.

Operating 36 manufacturing facilities worldwide and employing over 10,000 professionals globally, CUMI's operations span the entire value chain, from mining to the manufacturing of advanced products. As a comprehensive source, the company offers over 20,000 varieties of abrasives, electro minerals, ceramics, and refractory components.



Global Presence



Purpose

Making a
Material
Difference

Vision

We will be a globally admired company driving innovations in Materials Science towards sustained value creation for people and our planet.

Mission

We design, co-create and deliver sustainable solutions to make a significant positive difference to all our stakeholders.

How We Create Solutions



CUMI's Industrial Ceramics Division

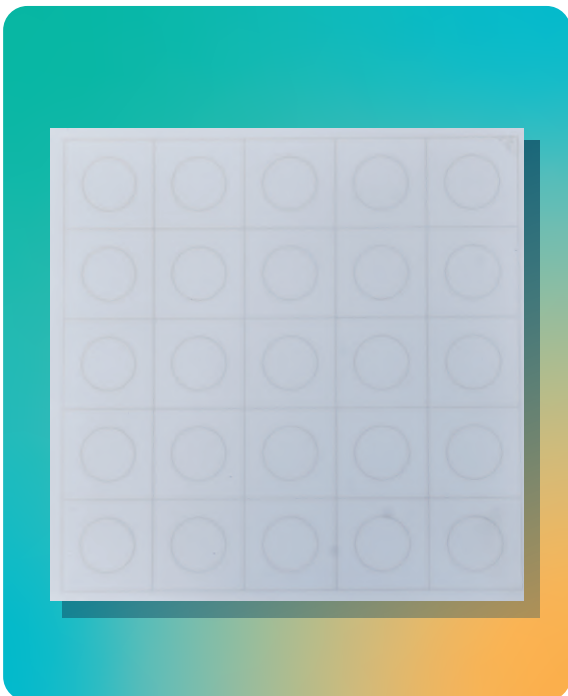
has established a strong presence in high alumina ceramics, backed by over 30 years of expertise in Advanced Materials. We specialize in providing cutting-edge ceramic solutions for various sectors, including Power and Energy Systems, Semiconductor and Electronics, Mobility, Defence and Aerospace, as well as Wear, Abrasion and Corrosion Protection in the Metal, Steel, Cement, and Mineral Processing industries. We are the second-largest manufacturer of metallized ceramics for vacuum interrupters globally. CUMI Ceramics is renowned for its design and application engineering capabilities, which rank among the best in the industry.



INDUSTRIAL
CERAMICS

MOBILITY

We provide superior material alternatives to fulfil the ever-growing demands of precision and accuracy of automotive products. Our products are capable of withstanding mechanical, electrical & thermal fatigue and thereby enhance the useful life of automotive components. We engineer and co-develop customized solutions with OEMs and automotive suppliers for their products as well as processes. We are continuously strengthening our presence in the dynamic automotive industry with our advanced ceramic component offerings in High Alumina ceramics, addressing applications in ICE, EV, high-speed railways and aerospace.



AUTOMOTIVE APPLICATIONS INCLUDE

- Insulators for Spark Plugs
- Oxygen Sensors
- Pressure Sensors
- Substrates for TFR Sensors
- Components for Fuel Injection Pumps and Exhaust Systems
- Insulator Cases for EV Fuses
- Substrates for EV Charging
- Metallized DC Contactors
- Inserts for High-Speed Railway

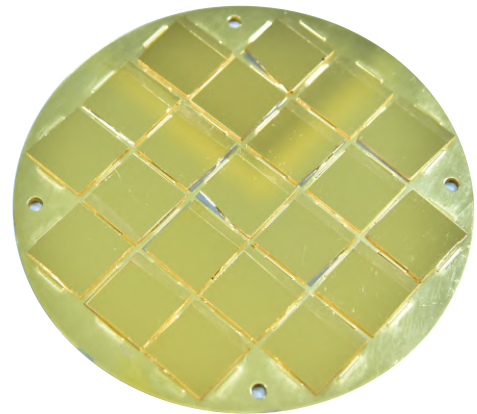
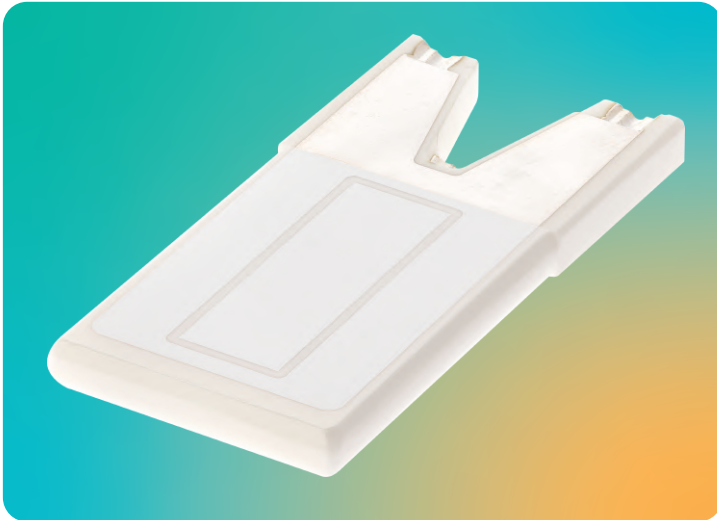


ELECTRICAL & ELECTRONICS

Ceramics are widely used for Electrical and Electronics applications due to their unique properties such as high electrical insulation properties, excellent thermal conductivity, and chemical stability.

With Specially engineered solutions for applications such as battery, communication devices, auto electronics, PCB's sensors, CUMI advanced ceramics increase the reliability of electronic system.

As market pioneer in precision ceramic component, we collaborate closely with OEM's and sub tiers to develop customised ceramic solutions.



- Insulators
- Substrates for electronic circuits
- Ceramics for Resistors, Inductors, Capacitors
- Heat Sinks
- Ceramic Substrates for IGBT heat sinks
- Sensors
- Setter plates for sintering
- Metallized Ceramics for Xenon Lamps
- Thick & thin film Metallized Substrates



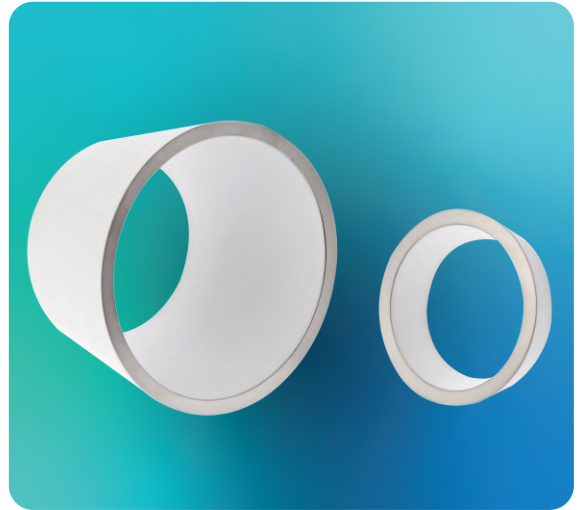
SEMICONDUCTOR

Ceramics play a crucial role in the semiconductor industry due to their unique properties.

We have tailor-made formulation in High Alumina (Semicon grade), and offer Precision Engineered Ceramic components for Semiconductor Wafer Fab Equipment.

APPLICATIONS

- Chemical Vapor Deposition (CVD)
- Physical Vapor Deposition (PVD)
- Etch
- Wafer Handling



VACUUM ELECTRONICS

VACUUM Electronics is the heart of many critical communication and optical devices used in Defense, Aerospace, Medical and Industrial applications.

CUMI pioneer in offering customised ceramic solutions for Vacuum and hermetic sealing. CUMI ceramics offer exemplary vacuum integrity and superior dielectric performance.

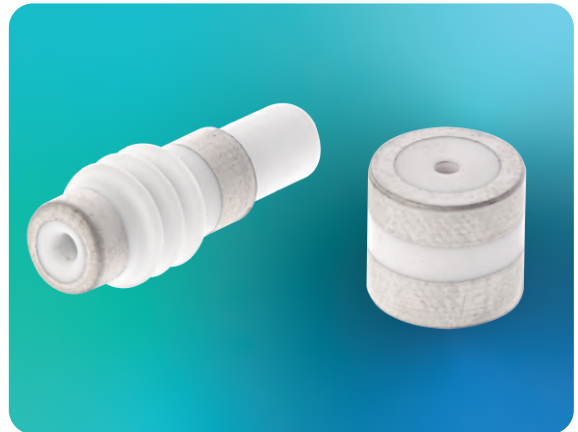
APPLICATIONS

- Metallized Ceramics for X-ray tubes and Linear Accelerators
- Metallized Ceramics for Electron and Microwave tubes, and image intensifiers
- Metallized Ceramics for Magnetron, Klystron, TWT and Gytrons
- Ceramics for Vacuum tubes, Spark gaps, Feedthroughs
- Window ceramics for RF applications



MATERIALS OFFERED

Ceramic – 92%, 94%, 97.5%, 99.5% Alumina
Metallization- Moly Manganese, Silver
Plating- Nickel, Copper, Silver



VACUUM INTERRUPTERS / CAPACITORS

CUMI is one of the largest suppliers by volume for High-purity Alumina Metallized Ceramic cylinders. These metallized cylinders from CUMI find their application worldwide for Vacuum interrupters and capacitors due to their excellent electrical insulation properties.

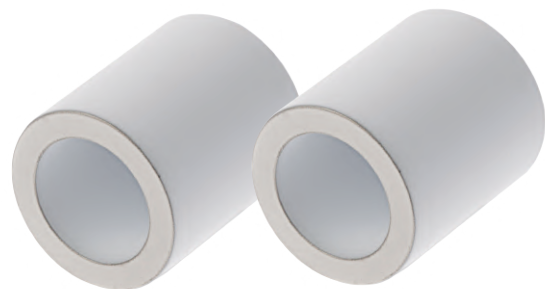
CUMI specializes in Moly Manganese (Mo-Mn) metallization along with nickel plating which enables excellent Hermetic sealing (Leak tight joints) for these metallised ceramic cylinders. The leak-tight joints help in maintaining the required vacuum level for efficient arc quenching in the interrupters.

The high mechanical strength of the Mo-Mn metallized layer also provides for a longer life for the Vacuum interrupters.



APPLICATIONS

- Vacuum interrupters in vacuum circuit breakers
- Vacuum Tubes
- Generator circuit breakers
- Relays
- Mining circuit breakers
- Capacitors
- Auto Recloser
- Contactors
- Fuse
- Isolators
- Load breaking switch
- Switchgear



BRAZED ASSEMBLIES

In addition to offering metallized ceramics, CUMI also offers ceramic-to-metal brazed parts with and without hermetic sealing for power, medical, and defence applications.

CUMI has also partnered with feedthrough manufacturers to supply of Electrical Feedthroughs and Viewports. These Feedthroughs play a pivotal role in Defense, Aerospace, Power, Atomic energy, semiconductors and equipments.

APPLICATIONS

- Electrical feedthroughs
- Electrical and Optical view ports
- Brazed Thyristors
- Brazed X-ray Feedthroughs.
- Brazed Relay / DC contactor

THERMAL CERAMICS

CUMITHERM – Ceramics for Non-Ferrous Molten Metal Handling Applications

Reaction-sintered aluminium Titanate is ideally suited for Non-Ferrous cast houses and foundries due to its extraordinary properties of high thermal shock resistance, low thermal conductivity and non-wettability to most Non-ferrous molten metals. These properties are achieved by combining high-purity alumina and titania in a precision-controlled reaction sintered process to engineer a micro-porous microstructure.

APPLICATIONS

- Feeders / Risers / Stalk for low-pressure die casting
- Dosing Tubes
- Sprue / Gate bushes, cups & Connectors
- Casting spouts, flow rods, retainer rings
- Nozzles, crucibles
- Tap hole plugs & rings
- Customised special components
- Launderers
- Induction heating



Our products for SOFC and SOEC applications include

- Structural components
- Electrolytes
- Metallized Dielectric components
- Glow Plugs
- Setter Plates for stack sintering

FUEL CELLS

Solid Oxide Fuel Cells (SOFC) hold an important place in energy conversion and storage systems due to their fuel flexibility, high efficiency, and environmental sustainability. On the reverse process, Solid Oxide Electrolysis Cells (SOEC) represent a crucial stride toward sustainable Hydrogen generation.

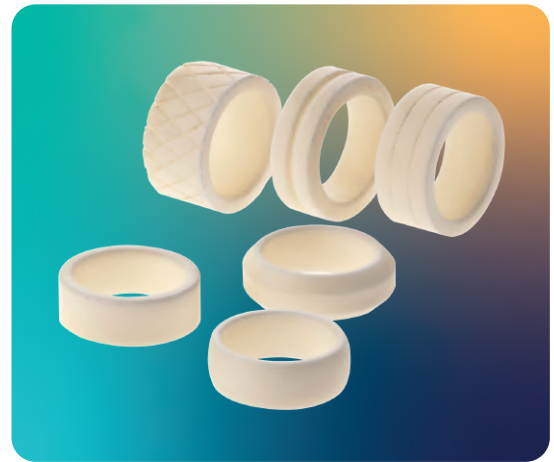
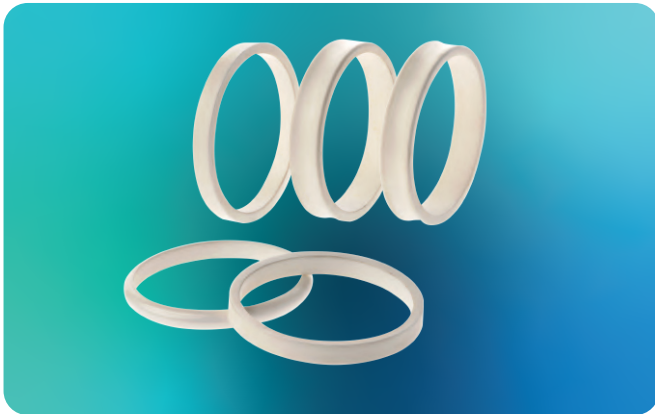
We offer high-performance ceramics for SOFC and SOEC in special High-Alumina formulations for high strength and durability.

FLUID HANDLING

In the transport of aggressive fluids, ceramic components provide exceptional resistance to corrosion, mechanical, erosion and abrasion while maintaining their superior surface finish and fit.

MATERIALS OFFERED

- High Alumina (95%, 99.5%, 99.8% purity)
- Reaction Bonded Silicone Carbide
- Zirconia



CERAMICS FOR SEALING APPLICATIONS

With high wear and corrosion resistance, our CUMITUFF ceramics are compatible with high-corrosive acids and alkalis except H₃PO₄ and HF.

CUMI also offers Ceramics with No Grinding Lead marks for Cartridge sealing applications.

CERAMICS FOR PUMP INDUSTRIES

CUMI offers high-performance material solutions that have proven successful wide range of applications in the Pump industry.

APPLICATIONS

- Pump Seals
- Pump shaft sleeves
- Pump plungers
- Pump cylinder liners
- Shaft Sleeves and Bush bearing
- Piston for Metering & Dosing pump

Our Ceramics finds its application in a wide variety of pumps like slurry pumps, centrifugal pumps, sealless-magnetic driven pumps, Canned Motor Pumps etc.,

CUSTOMIZED APPLICATION

CUMI has decades of expertise in producing customized ceramic solutions that are tailored to meet customer requirements, with precise dimensions and smooth surfaces. These products are crafted from Alumina ranging from 90% to 99.5%, Aluminium Titanate, Zirconia, Zirconia Toughened Alumina (ZTA) and Silicon Carbides.

Our engineered ceramics find applications across diversified segments like:

- Insulators for Electro Discharge Machines (EDM)
- Setter plates for Metal Injection Moulding (MIM) and Powder Injection Moulding (PIM)
- Ceramics in the Paper industry
 - Dewatering Elements
 - Centri cleaner Cones
 - Palm Guides
 - Hydro Cyclones
- Injection Moulded components for various industries
 - Textiles
 - Watches and Jewellery
 - Home appliances
- Zirconia ceramics for Tooling applications
 - Battery
 - Bearings
 - Pad Printing
 - Wire Drawing
- Nozzles for Sand Blasting application



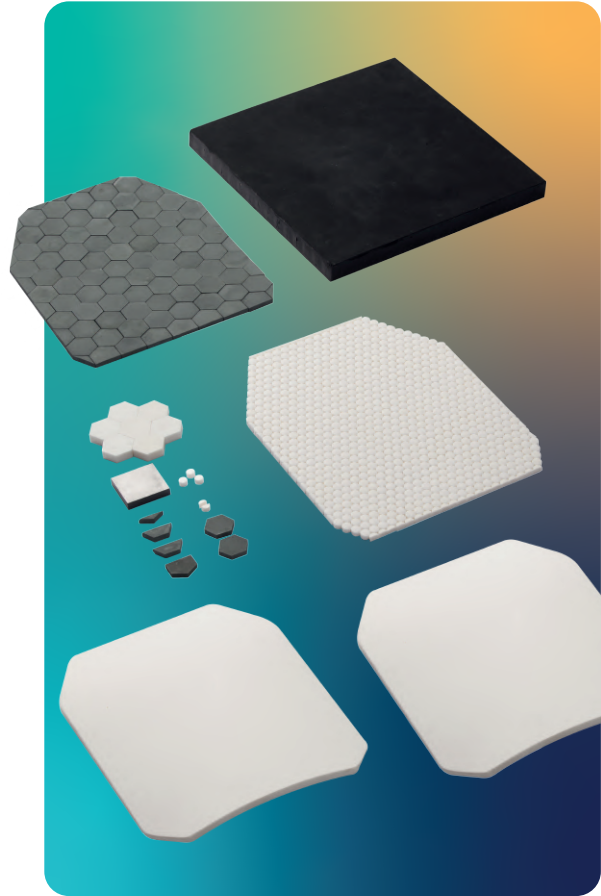
DEFENCE

We are pioneering cutting-edge advancements in Technical Ceramics for bulletproof vests and vehicle armour. Our best-in-class ceramic ballistic protection range is engineered from:

- Reaction Bonded Silicon Carbide (RBSiC)
- High Purity Alumina (99.5% and 99.6%)
- Zirconia Toughened Alumina (ZTA)
- Reaction Bonded Silicon Carbide + Boron Carbide (RBSiC + B4C)

Our solutions are lightweight, ergonomic and customizable for use in bulletproof vests. Innovations in vehicle armour such as rubberised ceramic panels are designed to provide structural and dimensional stability to the ceramic tiles. This enables tailored, precise contouring of the vehicle for added protection.

Our lightweight yet resilient solutions for personal and vehicle armour provide a much-needed alternative to conventional bulky and heavy metal armour. Our ceramic-based ballistic protection materials have been designed to meet threat levels conforming to the National Institute of Justice (NIJ) 'Level IV' and STANAG Level 3 global standards.



CUMI'S OFFERING FOR ARMOUR CERAMICS

PRODUCT	SIZE	THICKNESS	MATERIAL GRADE
Plain Tile	50 x 50	5 to 12mm	Alumina 99.5%, RBSiC, ZTA
Hex Tile	20 A / F, 22A / F, 30 A / F, 32 A / F	5 to 12mm	Alumina 99.5%, RBSiC
Segments	Dia, 10mm, 12mm, 15mm, 20mm	5 to 20mm	Alumina 99.5%, RBSiC, ZTA
Rubberised Pad	All of the above sizes	All of the above thickness levels	Alumina 99.5%, RBSiC, ZTA

Material Property Sheet

PROPERTIES		UNITS	TEST	CUMITUFF 90	CUMITUFF 92	CUMITUFF 92M	CUMITUFF 94M	CUMITUFF 95	CUMITUFF 96	CUMITUFF 96 Substrate	CUMITUFF 975M	CUMITUFF 995	
Chemical	COMPOSITION			90% Alumina	92% Alumina	92% Alumina	94% Alumina	95% Alumina	96% Alumina	96% Alumina Tape Cast	97.5% Alumina	99.5% Alumina	
Physical	DENSITY	gm/cc	ASTM C373-88(2006)	3.55	3.65	3.60	3.70	3.70	3.72	3.78	3.76	3.85	
	COLOUR	--	--	White	Ivory	White	White	White	White	White		Ivory	
Mechanical	WATER ABSORPTION	%	ASTM C373-88(2006)	0	0	0	0	0	0	0	0	0	
	ROCKWELL HARDNESS	R45N	ASTM E18 - 15	75	77	94 (R15N)	78	78	78	80		82	
	VICKERS HARDNESS	GPa	ASTM C1327-03	11.8	12.5	9.5	13.2	13.2	13	13.5	12.5	14.8	
	ELASTIC MODULUS	GPa	ASTM C1198-08	275	300	320	300	320	325	325		370	
Thermal	POISSON'S RATIO	--	ASTM C1198-08	0.22	0.22		0.22	0.22	0.22	0.22		0.22	
	FLEXURAL STRENGTH	MPa	ASTM C1161-02c (2008)	270	320	380	350	340	360	375	290	350	
	COMPRESSIVE STRENGTH	MPa	ASTM C1424-04	1750	1950	2200	2100	2200	2300	2400	1750	2600	
	FRACTURE TOUGHNESS	MPa.m ^{0.5}	ASTM C1421-01b (2007)	(3-4)	(4-5)		(4-5)	(4-5)	(4-5)	(4-5)	4	(4-5)	
	THERMAL CONDUCTIVITY	W/m-k	ASTM C1470-06	16.7	20.2		22.4	23	24.7	25		30	
Electrical	COEFFICIENT OF THERMAL EXPANSION @ 25-1000°C	10 ⁻⁶ /°C	ASTM C1470-06	8.1	8.1	7.6	8.2	8.2	8.2	8.2	8.9	8.2	
	MAX USE TEMPERATURE	°C	No load condition	1500	1500	1550	1700	1700	1700	1700		1750	
	THERMAL SHOCK, Tc	°C	ASTM C1525-04	250	250	160	250	250	250	250		200	
Electrical	DIELECTRIC STRENGTH	ac-kV/mm (3.18mm)	ASTM D149-97a(2004)	8.3	8.3	9	8.5	8.3	8.3	10 (3.18mm) 20 (0.25mm)	9	8.7	
	DIELECTRIC LOSS	25°C, @ 1MHZ	ASTM D2520-01	0.0004	0.0004	0.0003	0.0004	0.0002	0.0002	0.0002		0.0001	
	VOLUME RESISTIVITY	25°C, ohm-cm		>10 ⁻¹³	>10 ⁻¹³	>10 ⁻¹²	>10 ⁻¹³	>10 ⁻¹³	>10 ⁻¹³	>10 ⁻¹³	>10 ⁻¹³	>10 ⁻⁴	>10 ⁻¹⁴
		500°C, ohm-cm		4x10 ⁸	4x10 ⁸		4x10 ⁹	4x10 ⁹	4x10 ⁹	4x10 ⁹			2x10 ¹⁰
	1000°C, ohm-cm		5x10 ⁵	5x10 ⁵		5x10 ⁶	5x10 ⁶		1.0x10 ⁶			2x10 ⁶	
Prime characteristics				Good Wear Resistance	Excellent Wear Resistance		Excellent Electrical Insulation & Metallized Ceramics	Moderate wear & Corrosion resistance, Good Electrical Insulation & Thermal Conductivity	Excellent Wear Resistance & Thermal Application	Electrical & Electronic Application		Excellent Wear, Corrosion Resistance & Excellent Ballistic Properties	

NOTES:

- DATA MEASUREMENTS** - All data measurements are typical and made at room temperature unless otherwise noted.
 - COMPOSITION CONTROL** - All industrial ceramic compositions are controlled using modern chemical, spectrographic, and x-ray fluorescent methods.
 - THERMAL SHOCK RESISTANCE** - Tests are done by quenching samples into water from various elevated temperatures. The change in temperature where a sharp decrease in flexural strength is observed is listed as +Tc.
 - CHEMICAL RESISTANCE** - Although all industrial ceramic products are highly resistant, specific application data to be obtained from us prior to design finalisation to ensure optimum ceramic selection.
- This chart is intended to illustrate typical properties of CUMI ceramic materials. The designer should recognize that exact properties may vary according to product configuration and can sometimes be tailored to meet specific requirements. This information set forth herein not to be construed as absolute engineering data or constituting a warranty or representation for which we assume legal responsibility.

Material Property Sheet

PROPERTIES		UNITS	TEST	CUMITUFF 995M	CUMITUFF 996 Substrate	CUMITUFF 998	CUMIZIRTUUFF 14EC	CUMITHERM	CUMITUFF MgPSZ	CUMITUFF YPSZ	CUMICARB-R	CUMIBOROCARB
Chemical	COMPOSITION			99.5% Alumina	99.6% Alumina Tape Cast	99.8% Alumina	14% Zirconia Toughened Alumina, EC Grade	Al-Titanate	MgO-Partially stabilized Zirconia	Ytria-Partially stabilized Zirconia	RbSiC (88% SiC, min + 12% free Si), max	Rb(SiC+B4C) (57% SiC, 32% B4C, 11% free Si)
Physical	DENSITY	gm/cc	ASTM C373-88(2006)	3.83	3.90	3.87	4.10	3.30	5.70	6.00	3.05	2.80
	COLOUR	--	--	Ivory	White	Ivory	Ivory	White - Grey	White/Brown	Ivory	Black	Black
	WATER ABSORPTION	%	ASTM C373-88(2006)	0	0	0	0	5 - 10	0	0	0	0
Mechanical	ROCKWELL HARDNESS	R45N	ASTM E18 - 15	84	84	83	82	45	75.0	80.0	90 (HRA)	90 (HRA)
	VICKERS HARDNESS	GPa	ASTM C1327-03	13	15.2	15.0	14.0	4.5	11	12	22	24
	ELASTIC MODULUS	GPa	ASTM C1198-08	375	375	380	340	--	200	200	380	400
Thermal	POISSON'S RATIO	--	ASTM C1198-08	0.22	0.22	0.22	0.30	0.22	0.30	0.23	0.21	0.21
	FLEXURAL STRENGTH	MPa	ASTM C1161-02c (2008)	350	475	360	480	25	620	900	350	250
	COMPRESSIVE STRENGTH	MPa	ASTM C1424-04	2150	3000	2400	3000	300	2000	2700	2500	2500
Electrical	FRACTURE TOUGHNESS	MPa.m ^{0.5}	ASTM C1421-01b (2007)	(3-5)	(4-5)	(4-5)	(6.0 - 7.0)	--	(9-10)	(11-13)	(3-4)	(3-4)
	THERMAL CONDUCTIVITY	W/m-k	ASTM C1470-06	8.2	30	30	21	1.0	2.2	2.2	130	130
	COEFFICIENT OF THERMAL EXPANSION @ 25-1000°C	10 ⁻⁶ /°C	ASTM C1470-06	1600	1750	1750	1500	1000	1700	1600	1250	1250
Prime characteristics	MAX USE TEMPERATURE	°C	No load condition	250	200	200	300	850	350	350	400	400
	THERMAL SHOCK, Tc	°C	ASTM C1525-04	11.5 (3.18 mm) 28 (0.25 mm)	8.7	8.7	--	N/A	9.0	9.0	--	--
	DIELECTRIC STRENGTH	ac-kV/mm (3.18mm)	ASTM D149-97a(2004)	0.0002	0.0001	0.0001	0.0001	0.0010	0.0010	0.0010	>10 ¹³	>10 ⁵
Prime characteristics	DIELECTRIC LOSS	25°C, @ 1MHZ	ASTM D2520-01	>10 ⁻¹⁴	>10 ⁻¹⁴	>10 ⁻¹⁴	>10 ⁻¹⁴	>10 ¹³	>10 ¹³	>10 ¹³	>10 ⁵	>10 ⁵
	VOLUME RESISTIVITY	25°C, ohm-cm	ASTM D1829	2x10 ¹⁶	2x10 ¹⁶	2x10 ¹⁶	2x10 ¹⁶	2x10 ¹⁷	5x10 ⁴	2x10 ⁴	<10 ³	<10 ³
		1000°C, ohm-cm										

NOTES:

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MAKING A MATERIAL DIFFERENCE



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INDUSTRIAL
CERAMICS

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