Refractron Advanced Ceramics

Izory®HD for Oil and Gas

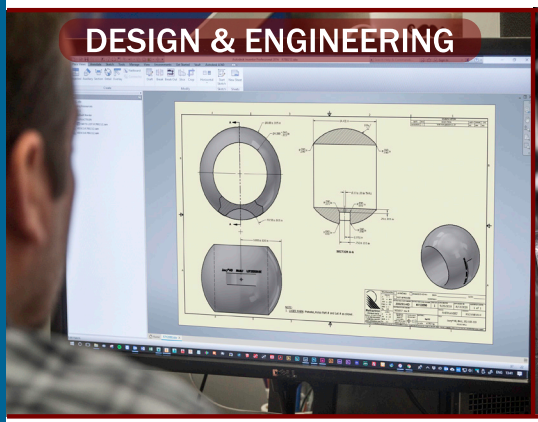
Why choose *Izory*®HD

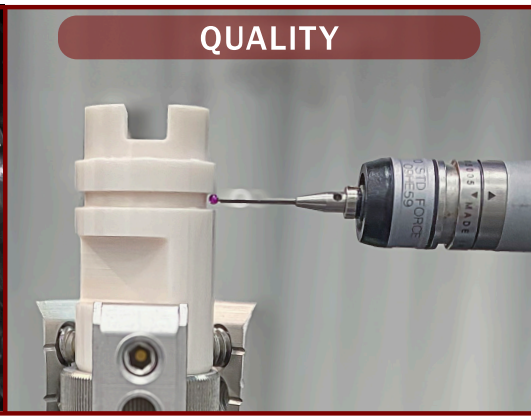
- ✓ Superior wear & corrosion resistance
- ✓ 2-3x tougher than SSiC, Alumina & Carbide
- ✓ Extend the life of mating parts

Improve Uptime
Reduce Costs

Why choose Refractron

- ✓ Made in the USA since 1984
- ✓ Responsive service and lead times
- ✓ Superior material selection & designs





1.315.331.6222
sales@refractron.com
www.refractron.com
5750 Stuart Avenue,
Newark, NY 14513, USA

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Refractron

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Have you benchmarked your supplier for performance, price & lead time

Izory®HD for Oil and Gas

Izory® HD (our proprietary MgPSZ formulation), was developed with an improved microstructure which translates into a 15% increase in hardness (HV1), a 30% increase in strength (MOR), and a 40% improvement in wear resistance over standard MgPSZ parts. Since the hardness and the microstructure have a direct impact on wear resistance, they are critical to the longevity and productivity of oil and gas equipment. *Izory*® HD can be polished to a pristine 1 micro inch Ra and our on-site grind shop can hold tolerances to .0001". It is used for seats and frac plugs as small as 6mm and as liners for mud pumps and meters with ID's as large as 12" and 20" long. In addition to *Izory*® HD, Refractron has expertise in HIPed YTZP and ATZ formulations, and can help guide discussions on advanced material selection.

Refractron understands how critical *Izory*® HD parts are to drilling operations so we routinely verify the ceramic properties of in house made material and utilize 100% inspection of critical dimensions to ensure proper fit. A unique laser mark is added to provide comprehensive traceability and ease of inventory control.

Izory® HD, Refractron's featured zirconia material for many applications in the oil & gas industry, will reset your expectations for the performance of critical components including:

- Pipeline "P.I.G." wear pads
- Relief valve balls and seats
- Choke cage liners
- Mud pump liners
- Frac plugs
- Choke beans
- Injection pump pistons
- MWD ceramic tools

Refractron is a privately owned company that has been manufacturing ceramics in its 95k ft² factory near Rochester, New York since 1984. Contact us (sales@refractron.com) if you have questions, or would like to set up an on site fit assessment with an engineer.

PROPERTIES	MgPSZ	Y-TZP		ATZ (10)	ATZ (20)
	Izory® HD	Dark HIPed	HIPed	HIPed	HIPed
COLOR	Ivory	Tan	White or Gray	White	White
CHEMISTRY: $ZrO_2 + HfO_2 + MgO$ *[%]*	97.14				
$ZrO_2 + HfO_2 + Y_2O_3$ *[%]*		99.50	99.70	89.95	79.95
Al_2O_3 *[%]*		0.25	0.25	10.00	20.00
Other *[%]*	2.86	0.25	0.05	0.05	0.05
DENSITY *[g/cm³]* *ISO 18754*	5.78	6.08	6.08	5.79	5.45
FRACTURE TOUGHNESS K_{IC} *[MPAm$^{1/2}$]* *ASTM C-1421*	10	5	5.2	9.0	-
LOOP ABRASION *[mm³]* *ASTM G174 (d)*	0.100	0.100	0.100	0.020	-
MODULUS OF ELASTICITY MOE *[GPa]* *ASTM E1876-99*	214	214	214	296	296
MODULUS OF RUPTURE 4pt MOR *[MPa]* *ASTM C-1161*	650	1350	1350	1050	1600
HARDNESS VICKERS *[HV1]* *ASTM C1327-08*	1225	1425	1660	1430	1550
COEFFICIENT OF THERMAL EXP. x10⁻⁶/°C *[25-1000 °C]* *ASTM C372*	10.2	10.7	10.7	9.0	9.0
MAXIMUM USE LIMIT *[°C]* *ISO 18754*	500	1500	1500	1500	1500

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