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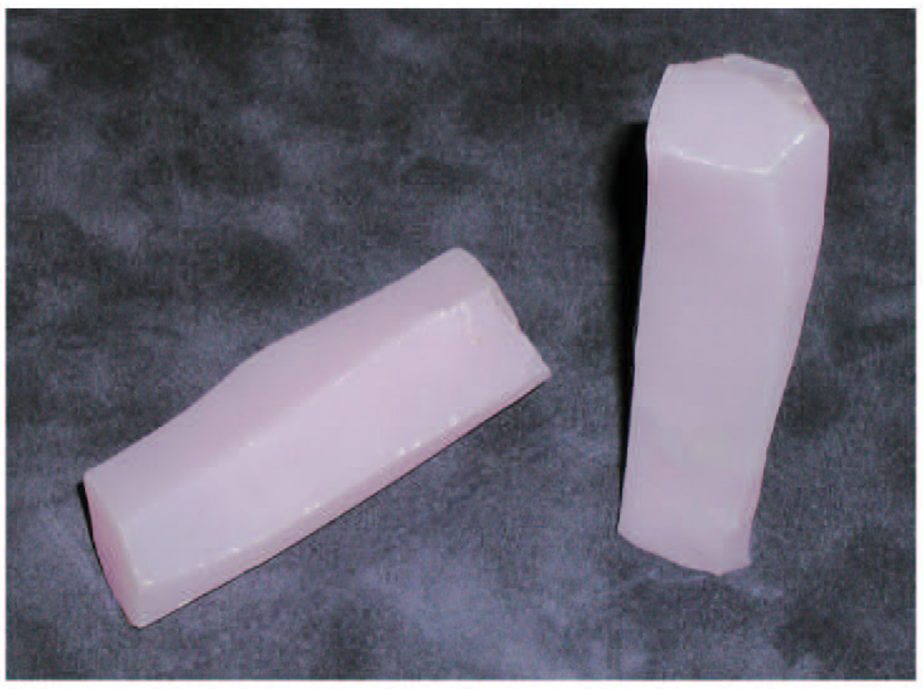
TECHNICAL DATA

CRYSTAL PSZ – a new material

CRYSTAL PSZ – is tougher, has higher hot strength, is stronger and harder than ceramics or sapphire with lower friction for bearings, wear surfaces and cutting tools.

CRYSTAL PSZ is a new non-metallic structural material, with a combination of strength, high crack resistance, chemical inertness and resistance in oxidizing atmosphere at a wide temperature range.

This material is made utilizing proprietary high frequency, cold container induction melting technology. After fusion, the material is melt oriented in the **tetragonal** crystal form. This technology has been found to be a highly productive, scrap free method for the production of PSZ crystals up to 40 mm in cross-section and up to120 mm in length. The resulting material will have fine crystal domains in the size range of 10 to 100 nm. To distinguish this new material from its ceramic counter part as well as the more common cubic form of crystalline zirconia, we refer to this material as **CRYSTAL PSZ**.



Just like sapphire, the single crystal form of alumina, which has superior properties over ceramic form of alumina, CRYSTAL PSZ has a whole set of improved mechanical properties over the same material fabricated using standard ceramic techniques. For example PSZ crystals have a high strength, (compared to strength of the ceramic form of partially stabilized zirconia) as well as an increased crack resistance.

Strength characteristics of CRYSTAL PSZ remain high under elevated temperatures up to 1400^{0}C in oxidizing atmospheres and increase of up to 70% when the temperature are reduced to – 140^{0}C. Ceramic materials, such as alumina, at elevated temperatures undergo re-crystallization with an accompanying deterioration of mechanic properties.

CRYSTAL PSZ have increased inertness to acids, alkalis, bio-fluids, and high temperature steam. It also exhibits extremely high resistance to abrasive wear and **anomalous low friction coefficient** of only 0.04 on steel and 0.08 on alloys. This compares to 0.15 for sapphire on steel and 0.58 for clean steel on steel. Its coefficient of friction is better than even lubricated steel on steel. Lower friction means lower wear on both surfaces. Some of the main parameters of the CRYSTAL PSZ in comparison with other materials such as sapphire and the ceramic version of psz are found in the following table.

Comparison physical and mechanical parameters of high-strength structural non-metallic materials

Property	Oxide Materials					Silicon Based	
	CRYSTAL PSZ	**Ceramic PSZ**		**Single Crystals**		**Nitride**	**Carbide**
	ZrO_2- Y_2O_3	Y-PSZ	Mg-PSZ	Cubic Zirconia 9-mole%)	Sapphire Al_2O_3	Si_3N_4	SiC
Density, gm/cm^3	6.08	6.05	5.75	5.8	3.96	3.2	3.2
Bending strength, MPa @ 20° C @1200° C @1400° C	500-1600 - 700	1000 500 -	800 500 -	200-400	300-500	600-900	500-600
Crack resistance, K_{1c}MPa.m$^{1/2}$	8-14	7-12	7-12	2-4	3-4	5-7	3-4
Micro hardness, HPa	12-15	13	11	12-16	19	16	28
Coef. Of Friction On Steel On Alloy	 0.04 0.08				 0.15 -		
TE 10^6C^{-1}	9.3-11.4	10.4	10.48	10 - 11	10.48	12-16	4.2

Applications of CRYSTAL PSZ

Wear and Structural Parts - CRYSTAL PSZ can be used to make structural parts, operating in extreme conditions of high mechanical stress, corrosive mediums, high temperatures, lack of lubrication, etc. These can include:

- Journal bearings and friction bearings
- Prisms for precession devices
- Engine Valves
- Instrument guide rails
- Spray nozzles
- Wear surfaces
- Wire Bonding Capillaries

*Its extremely low coefficient of friction makes **CRYSTAL PSZ a natural replacement and significant improvement over sapphire in jewel bearings**.*

Cutting Tools and Industrial Knife Blades: Owing to a fine-domain (10-100 nanometers) nanostructure of CRYSTAL PSZ, its high mechanical strength and crack resistance, it can be used to produce extremely wear resistant tools with the very sharpest of cutting edges. CRYSTAL PSZ cutting tools have high high-accuracy for the machining of different materials (metal, wood, glass, crystals, Kevlar, etc.) and for high quality medical tools.

Surgical scalpels: One promising application of this material is production of super sharp wear resistant surgery tools. The traditional metal scalpels cannot be sharpened up to less than 1 micrometer due to graininess of their microstructure. If an attempt is made to increase sharpness of a cutting edge beyond this point, the relative low strength of the material will cause the cutting edge to be deformed, even in case of low load. Metal scalpels wear out after a relatively short period of time due to corrosive environment.

Non-metallic scalpels existing today – made of diamond, sapphire, and natural minerals such as basalt and obsidian – can have a sharper cutting edge and longer life due to inherent high strength. Such scalpels are chemically and biologically inert, wear resistance and have low friction coefficients and maintain their cutting edge.

Monolithic crystal diamond scalpels are limited in size and can only be used for a narrow range of operations such as ophthalmology. They are also expensive. Sapphire and obsidian (volcanic glass) scalpels are characterized by increased fragility and subject to breaking during an operation.

CRYSTAL PSZ scalpels for general purpose offer a super sharp cutting edge (0.1-1.0 micron) without significant chips. Clinical trials have demonstrated the suitability of repeated use of CRYSTAL PSZ scalpels (they have been used for more than 100 operations without degradation of cutting properties). Low surgical trauma, chemical inertness and biological compatibility with tissues contribute to reduced healing time after an operation.

The size and relative cost of CRYSTAL PSZ ingots provides an opportunity to produce economical scalpels of any size that can be used for a wide range of operations, requiring high accuracy of cutting and minimal trauma. These scalpels can be used in maxillofacial (including cosmetology), neuro, cardio, vascular, embryonic, and ocular surgery.

Medical Implants - Bio-inertness of this material makes it a promising material for use in dental and orthopedic implants. The ceramic form of PSZ is already approved for use in orthopaedic devices such as hip replacements.