



HIGH PERFORMANCE PEEK™ POLYMERS

### NEW STANDARD FOR POLYMER PURITY

Victrex introduces its new VICTREX Ultra-High Purity (UHP) PEEK polyaryletherketone. This specially manufactured polymer meets the strictest requirements for extractables in cleanroom, wet processing, pharmaceutical processing and analytical chemistry applications. VICTREX UHP PEEK contains no additives, fillers, or stabilizers which could leach into fluid stream or outgas in vacuum or high heat environments. Additionally, VICTREX UHP PEEK offers all the superior mechanical, chemical, thermal and tribological properties of standard Victrex grades.

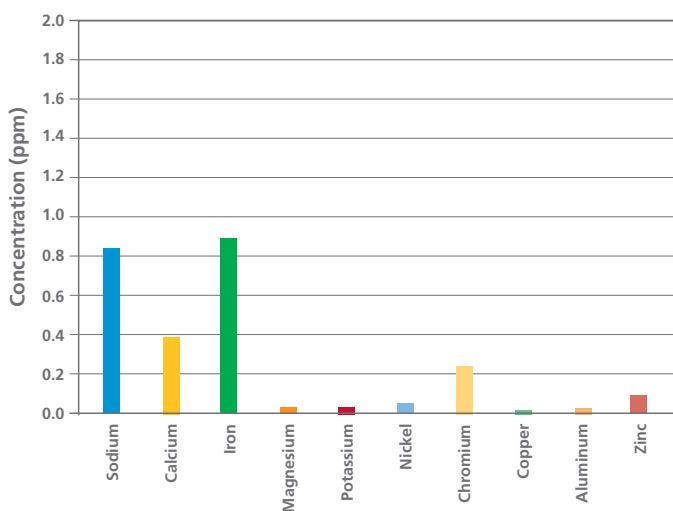
### INHERENT POLYMER PURITY

Several high technology industries require very pure materials in manufacturing and test processes. For example, semiconductor fabs prevent yield loss and wafer defects by using high purity materials in process and handling equipment to prevent inadvertent wafer doping and particulate sloughing. Chemical analytical test equipment uses high purity materials to prevent contamination which causes inaccurate measurements.



The selling specifications for VICTREX UHP PEEK powder sets a limit of less than one part per million for each of the following metals.

Figure 1: Typical Metal Content in VICTREX UHP PEEK\*



Semiconductor manufacturers are extremely concerned about the level of metallic ions in their materials because they are capable of migrating into a wafer causing defects and poor yield.

\*Testing on VICTREX Ultra-High Purity PEEK powder was conducted at an independent laboratory

Table 1

#### VICTREX UHP PEEK Driving Down Metal Content to Less Than 1 ppm for Each Metal

Aluminum	Indium	Silicon
Antimony	Iron	Silver
Arsenic	Lead	Sodium
Barium	Lithium	Strontium
Beryllium	Mercury	Sulfur
Bismuth	Magnesium	Tantalum
Boron	Manganese	Tellurium
Cadmium	Molybdenum	Thallium
Calcium	Nickel	Tin
Chromium	Niobium	Titanium
Cobalt	Phosphorus	Tungsten
Copper	Potassium	Vanadium
Gallium	Rubidium	Yttrium
Germanium	Scandium	Zinc
Hafnium	Selenium	Zirconium

For Applications That Demand Strict Purity Requirements

# VICTREX® Ultra-High Purity PEEK Polymers...

## EXTRACTION STUDIES

Not only does VICTREX UHP PEEK have exceptional bulk purity, very little leaches from the polymer.

*A Leaching Experiment for Cations* was carried out on 30g pellet samples in ultrapure water for four hours at 70°C (158°F) in 5% nitric acid with the following results:

Element	Reporting Limit (µg/g of sample) ppm	VICTREX UHP PEEK (µg/g sample) ppm
Aluminum	0.0002	0.0048
Barium	0.00008	0.00009
Calcium	0.002	0.060
Chromium	0.0002	0.0013
Copper	0.0002	0.0004
Iron	0.002	0.024
Magnesium	0.0002	0.0029
Potassium	0.002	0.003
Sodium	0.0002	0.0095

*A Leaching Experiment for Anions* was carried out on molded disks in ultrapure water for 7 days at 85°C (185°F) with the following results:

Anions	Reporting Limit (µg/cm <sup>2</sup> )	VICTREX UHP PEEK Molded Disk (µg/cm <sup>2</sup> )
Fluoride	0.004	0.22
Chloride	0.007	0.0098
Bromide	0.02	0
Phosphate	0.02	0
Sulphate	0.02	0.36
Formate	0.04	0

## Outgassing

Due to the processing method and inherent purity, VICTREX UHP PEEK sets the standard for low outgassing performance. The table below lists values from pellets baked at 100°C (212°F) and 250°C (482°F) for 30 minutes. The primary organic material that outgases is diphenylsulfone. Measurements of the volatile components were quantified and characterized by Dynamic Headspace Thermal Desorption-Gas Chromatography-Mass Spectroscopy with the following results:

Temperature	Reporting Limit (ppmw)	VICTREX UHP PEEK Pellets (ppmw)
100°C (212°F)	0.1	0.0
250°C (482°F)	0.1	11.1

## PLASMA ETCH RESISTANCE

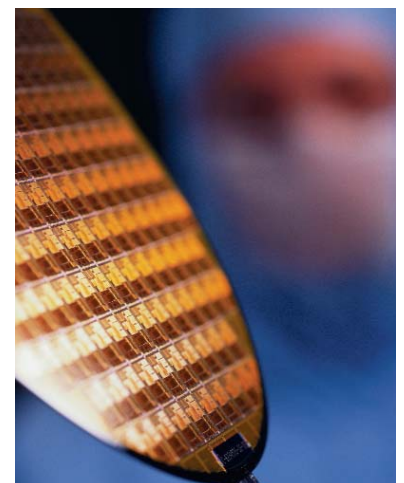
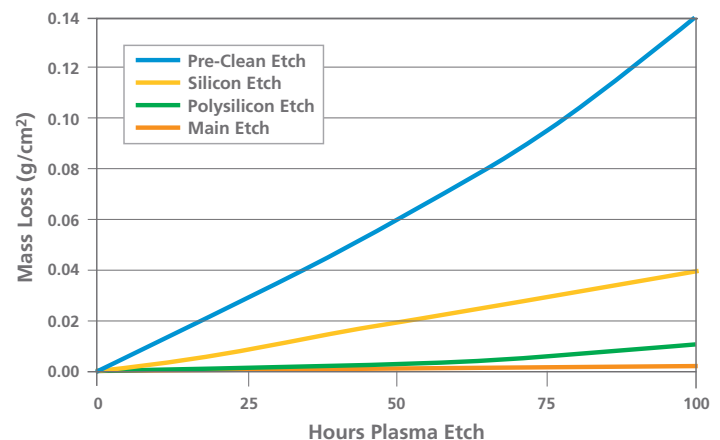
Victrex UHP PEEK is an ideal candidate for plasma etch processes used in semiconductor wafer manufacture. In addition to being a material which doesn't leach wafer damaging ions onto wafers, Victrex UHP PEEK erodes very slowly in a variety of plasma gases, outgases essentially no volatile organics, and is both thermally and mechanically stable to the process conditions.

Tests were performed in several gas mixtures to represent different etch environments. They were:

Pre-Clean Etch	100% O <sub>2</sub>
Silicon Etch	95% CF <sub>4</sub> + 5% O <sub>2</sub>
Polysilicon Etch	50% CHF <sub>3</sub> + 25% HBr + 12.5 O <sub>2</sub> + 12.5% Cl <sub>2</sub>
Main Etch	75% Cl <sub>2</sub> + 25% HBr

Tests were done on 10.3 cm<sup>2</sup> plaques. VICTREX UHP PEEK exhibited better durability than polyimides in all the gas mixtures tested. Data courtesy of Quadrant Engineering Plastics.

Figure 2: Plasma Etch Resistance of VICTREX UHP PEEK



# ...for applications that demand strict purity requirements

## ADDITIONAL KEY PROPERTIES

- **High Temperature Performance** — Due to exceptional melt stability, molded and extruded shapes have very consistent properties. Semi-crystalline material retains mechanical properties well above the polymer's glass transition temperature. Suitable for high temperature environments due to excellent resistance to thermal oxidation.
- **Chemical Resistance** — Insoluble in all common solvents. Excellent resistance to acids, bases, hydrocarbons, salts and steam. Superior chemical resistance to many metals including stainless steel and titanium. Performs well in harsh environments containing oxidizing agents such as hydrogen peroxide and ozone. VICTREX UHP PEEK has substantially lower moisture absorption than polyimides.
- **Tribological Properties** — Inherently lubricious, very smooth surface finish, low sloughing and exceptional abrasion resistance to prevent particulate contamination.
- **Strength, Toughness, Dimensional Stability** — Highest room temperature stiffness of any thermoplastic. Excellent fatigue resistance across broad temperature range. Low water absorption reduces outgassing and improves part dimensional tolerances. Very low creep. Superior mechanical properties compared to fluoropolymers.
- **Electrical Properties** — Very stable electrical properties over a wide range of temperatures, frequencies and humidities.
- **Safe Combustion Products** — Inherently UL V-0 material at 1.5 mm. Contains no halogens or flame retardants. Very low levels of smoke. Combustion products mostly carbon dioxide and water.
- **Ease of Processing** — Product can be extruded into a wide range of rod, tube and slab sizes. Easily machined with excellent tolerance control and surface finish. Can be readily injection molded on standard molding equipment.

## APPLICATIONS BY INDUSTRY

VICTREX UHP PEEK is suitable for applications requiring exceptionally high purity, strength, chemical inertness and abrasion resistance in the following industries:



**Semiconductor:** dry etch components such as focus rings, fasteners, chamber insulators and seals. Wet etch wafer chucks, fixtures and rollers. Wafer contact components including carriers, wands and reticle holders.



**Pharmaceutical Processing:** fluid handling components such as pumps, tubing, process piping and valves

**Chemical Processing:** analytical equipment components such as meters, valves, instruments, vessels, fittings and manifolds.



Property	Conditions	Test Method	Units	VICTREX UHP PEEK
<b>General</b>				
Color			n/a	Natural/Beige
Density	Crystalline Amorphous	ISO 1183	g/cm <sup>3</sup>	1.30 1.26
Typical Crystallinity		n/a	%	35
Water Absorption	24 h, 23°C/73°F Equilibrium, 23°C/73°F	ISO 62	%	0.50 0.50
<b>Mechanical</b>				
Tensile Strength	Yield, 23°C/73°F	ASTM D638	MPa (psi)	97 (14,000)
	Yield, 250°C/482°F	50 mm min-1 (2 in/min)		13 (1900)
	Break, 23°C/73°F	ASTM D638	MPa (psi)	
Tensile Elongation	Break, 250°C/482°F	5 mm min-1 (0.2 in/min)		
	Break, 23°C/73°F	ASTM D638	%	>60
Tensile Modulus	Yield, 23°C/73°F	type v bar		5
	23°C/73°F	ASTM D638	GPa (psi)	3.5 (507,500)
Flexural Strength	23°C/73°F	ASTM D790	MPa (psi)	156 (22,400)
	120°C/248°F			100 (14,500)
	250°C/482°F			13 (1885)
Flexural Modulus	23°C/73°F	ASTM D790	GPa (psi)	4.1 (600,000)
	120°C/248°F			4.0 (580,000)
	250°C/482°F			0.3 (43,500)
Shear Strength	23°C/73°F	ASTM D3846	MPa (psi)	53 (7685)
Shear Modulus	23°C/73°F	ASTM D3846	GPa (psi)	1.3 (188,500)
Compression Strength	Flow, 23°C/73°F	ASTM D695	MPa (psi)	118 (17,000)
	Trans, 23°C/73°F			119 (17,250)
Poisson's Ratio	23°C/73°F	ASTM D638	n/a	0.40
Rockwell Hardness	M Scale	ASTM D785		99
Charpy Impact Strength	2 mm (0.08 in) notch, 23°C/73°F	ISO 179	Jm-1 (ft lb/in)	35 (6.4)
	0.25 mm (0.01 in) notch, 23°C/73°F			8.2 (1.5)
Izod Impact Strength	0.25 mm (0.01 in) notch, 23°C/73°F	ASTM D256	Jm-1 (ft lb/in)	94 (1.79)
	Unnotched, 23°C/73°F			no break
<b>Thermal</b>				
Melting Point		DSC	°C (°F)	343 (649)
Glass Transition (Tg)		DSC	°C (°F)	143 (289)
Specific Heat Capacity		DSC	kJ kg <sup>-1</sup> °C <sup>-1</sup> (Btu lb <sup>-1</sup> °F <sup>-1</sup> )	2.16 (0.52)
Coefficient of Thermal Expansion		ASTM D696	10 <sup>-5</sup> °C <sup>-1</sup> (10 <sup>-5</sup> °F <sup>-1</sup> )	4.7 (2.6)
	Below Tg			10.8 (6.0)
Heat Deflection Temperature	Above Tg	ISO 75	°C (°F)	152 (306)
Thermal Conductivity	1.8 MPa (264 psi)	ASTM C177	W m <sup>-1</sup> °C <sup>-1</sup> (Btu in h <sup>-1</sup> ft <sup>-2</sup> °F <sup>-1</sup> )	0.25 (1.73)
<b>Fire, Smoke &amp; Toxicity</b>				
Flammability Rating		UL94	n/a	V-0@1.5 mm (0.059 in)
Limiting Oxygen Index		ISO 4589	% O <sub>2</sub>	24
	0.4 mm (0.0157 in) thickness			35
<b>Electrical Properties</b>				
Dielectric Strength	3.2 mm (0.126 in) thickness			
		IEC 248	kV mm <sup>-1</sup>	
Comparative Tracking Index	50 µm (0.002 in) film	IEC 112	Volts	190
Loss Tangent	23°C/73°F	IEC 112	n/a	150
Dielectric Constant	23°C/73°F, 1 MHz	IEC 250	n/a	0.003
	50 Hz, 0-150°C/32-302°F	IEC 250	n/a	3.2
Volume Resistivity	50 Hz, 200°C/392°F	IEC 93	10 <sup>16</sup> Ω cm	4.54.9

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