Advanced Engineering Plastics for Semiconductor and Electronics Manufacturing Equipment

A Guide to Materials That Boost Productivity, Consistency and Quality

QUADRANT

You inspire . . . we materialize®

Production and fabrication facilities have challenged their engineering teams to …

- **Increase and optimize output from existing investments**
- **Reduce maintenance and downtime to stretch capacity beyond historical levels**
- **Cut "cost in use" of new designs and rebuilt equipment**

The same engineers tell us that new materials solutions are needed for today's higher demands.

- **Materials have to survive repeated and severe ESD events to avoid undue yield losses.**
- **Parts must wear longer to extend time between maintenance and repair shutdowns and improve production life.**
- **Purity in processing has to improve for higher and more consistent output.**
- **Component and package designs are getting smaller and more precise.**

There are new choices for these new challenges: Quadrant's Extreme Materials.

Our technology innovations continuously re-set upper limits on material performance, and form the basis for our Extreme Materials that can ...

- **Satisfy tougher application requirements for ESd and ultra-high purity**
- **Outwear standard materials by a factor of 10 or more, keeping production equipment in service longer**
- **Hold precise tolerances on dimensions over wide temperature swings under load**
- **Survive a broad range of chemicals and temperatures**

This guide helps you simplify things.

A few key properties of engineering plastics—working in concert—have a major effect on equipment productivity. This guide helps simplify the material selection challenge.

- **It groups materials by their application area, temperature capability and important application needs.**
- **Each group then compares materials on the most important properties.**
- **It also compares another key factor—relative cost.**

Get there faster with our full range of application development, machining support and quality system services to speed your material solutions from concept through production.

Quadrant has become the world leader in engineering plastics for machining, not just based on our technology and broad materials portfolio but also our unmatched tech support, and highly capable plastics distribution network. Contact us online at www.quadrantplastics.com or 800.366.0300.

Materials for **Dry Process Applications:**

Materials such as quartz, ceramics and coated metals are widely used in current process chamber designs. Most engineers select these materials because they were the historic, acceptable standards for industrial equipment. While well understood, components fabricated from these traditional materials are costly, fragile and frequently fail to survive their full useful life. The aggressive process environment and routine cleaning puts expensive parts, made from these traditional materials at risk of damage - and the resulting process losses due to bad or unsuccessful cleaning cycles. Disposable components produced from new, high-purity plastics eliminate these risks - at no cost penalty.

Quadrant continues to develop materials that withstand the evolving chemical and temperature extremes of etch and handling applications. Our innovations are the result of testing done in our own labs — testing based on the industry's feedback on process conditions. One of the latest developments is a new material that raises the bar on ultra-high ionic purity.

Use the property data in the back of this guide to select your material based on the thermal performance (measured by HDT— Heat Deflection Temperature) and additional attributes listed below. Full application support is also available online at **www.quadrantplastics.com**.

Materials Overview

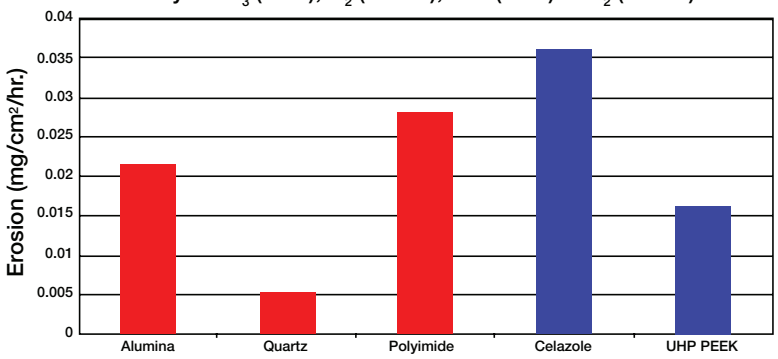
Ketron® UHP 320 PEEK

- Ultra-high purity coupled with the performance of Ketron PEEK (see Etch Rate chart)
- Low metal ions — critical ions 1 ppm or lower
- Cost Effective alternative to Polyimide materials

Celazole® PBI

- Extraordinary temperature resistance to over 800°F (425°C) (excursions over 1,100°F or nearly 600°C, are possible)
- Very low thermal oxidative degradation
- High purity — critical ions 10 ppm or lower

Polysilicon Glass Etch Rate (Lower is Better–mg/cm²/hr)
Chemistry: CHF_3 (50%), O_2 (12.5%), HBr (25%) & Cl_2 (12.5%)



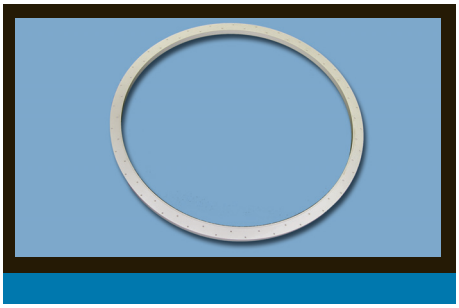
Ketron UHP 320 PEEK

IONIC IMPURITIES—Chemistry: Total Digestion Method
Units: ppm

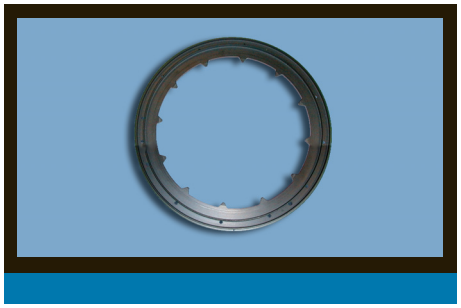
Aluminum (Al)	0.046	Magnesium (Mg)	0.097
Barium (Ba)	0.010	Manganese (Mn)	0.020
Calcium (Ca)	1.100	Nickel (Ni)	0.023
Chromium (Cr)	0.033	Potassium (K)	0.050
Copper (Cu)	0.009	Sodium (Na)	0.900
Iron (Fe)	0.400	Strontium (Sr)	0.150
Lead (Pb)	0.005	Titanium (Ti)	0.010
Lithium (Li)	0.000	Zinc (Zn)	0.030

Design Tip:

Our technology takes existing materials and creates upgrades like Ketron UHP 320 PEEK to meet more demanding process environments. This innovation takes its direction from users who share their new process and production requirements with our polymer scientists.



Ketron® UHP 320 PEEK Focus Ring



Celazole® PBI Clamp Ring

Materials used in the construction of wet process tools need to be resistant to a broad range of aggressive environments. No one plastic can do it all - and be cost-effective. Quadrant offers the broadest range of chemically resistant plastics for wet benches - allowing for the elimination of metals throughout the entire system.

Most engineers in this process area asked for high-purity, consistent high-quality appearance, corrosion and stain resistance, and ease of fabrication. Quadrant delivered with a broad range of solutions—from our FM certified Symalit fluoropolymer materials for housings and benches, to our structurally strong engineering materials. MSDS and property information plus full application support is available at **www.quadrantplastics.com**.

Materials Overview

Symalit® PVDF (Kynar®)
- FM4910 certified sheet and resin
- Consistent color; high-gloss masked surface
- High purity, excellent chemical resistance
- Tolerances in accordance to ASTM D6713-01
- Easy to fabricate

Symalit® ECTFE (Halar®)
- Wide range of chemical resistance, especially high pH
- Excellent toughness, durability
- FM4910 certified sheet and resin
- Consistent color; excellent surface appearance
- High purity, resists solvents, strong acids and bases
- Tolerances per ASTM D6713-01

Proteus® PP
- Easily fabricated into complex housings and panels
- Very good chemical resistance

Techtron® PPS
- Unsurpassed chemical resistance and strength at 250°F and below
- Exceptional machinability and dimensional stability
- Super low moisture absorption

Ketron® UHP 320 PEEK
- Extremely low metal ion content

Ketron® 1000 PEEK
- Excellent chemical resistance to 320°F
- Mechanically strong and stable under load
- Excellent machinability to precise tolerances

Ertalyte® PET-P
- Good chemical resistance and strength to 240°F
- Very low-moisture absorption; high-dimensional stability
- Consistent white appearance

Design Tip:
From concept through production, our tech support team can help speed your idea to reality. Connect with over 60 years of material selection and fabrication experience at 1-800-366-0300 or online at www.quadrantplastics.com.

Chemical Compatibility of Plastic Wet Bench Materials (Lower Values=BetterPerformance)

	SC1 ($NH_4OH:H_2O_2$)	SC2 ($HCl:H_2O_2$)	Hydrofluoric Acid (HF)	Nitric Acid (HNO_3)	SPM(Pirahna) ($H_2SO_4:H_2O_2$)	DI UHP Water	
	Extraction Parameter*					Leaching Parameter*	TOC*
Symalit® ECTFE (Halar®)	10	6	55	10	19	249	11.8
Symalit® PVDF (Kynar®)	39	178	167	37	85	905	4.2
Ketron® PEEK	1	61	75			126	0.2
Techtron® PPS		115	144			107	0.9
Ertalyte® PET-P	12	131				84	1.7

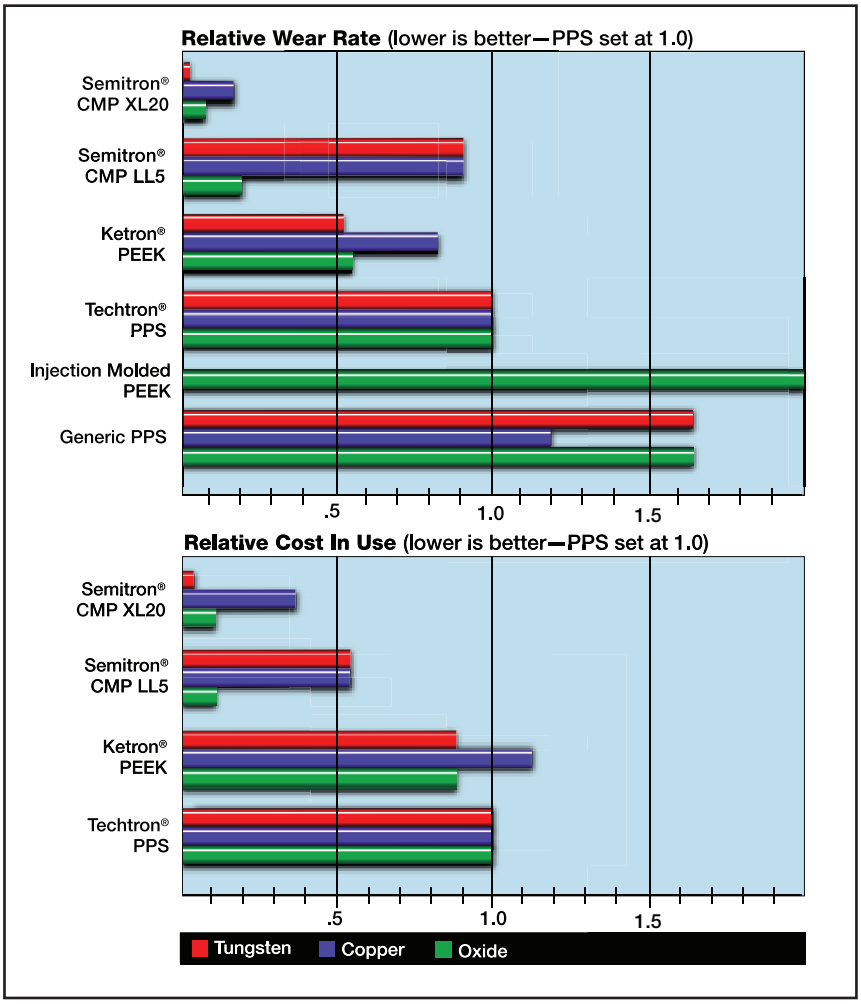
* Based on: Sematech Process Compatibility Parameters for Wet Bench Plastic Materials (#98123623A-ENG)

Accepted Industry standard | Not Recommended | Best in class

Wet Benches built from Proteus® PP and Symalit® PVDF

Advanced Materials for **CMP Applications:**

CMP designers and users demand more productivity from their tools while delivering ever increasing reliability in their process. Next generation materials for retaining rings from Quadrant can provide significant increases in tool uptime and enhanced process control. These new materials offer dramatic decreases in cost per wafer and deliver increased capacity in the installed tool base. The diverse environments and conditions of different CMP processes require a portfolio of materials for optimum cost, productivity and quality. Our "real world" test equipment, coupled with a strong knowledge of process conditions and output requirements, have helped us develop a family of materials to meet specific needs - by process type - for uniformity within a wafer, and consistency from wafer to wafer. Our latest additions: Semitron CMP LL5 and Semitron CMP XL20 are longer life materials that provide higher output and greater consistency that reduce cost per wafer. For product performance data, safety information and detailed machining informtion, contact us at **www.quadrantplastics.com**.



Materials Overview

Lowest cost in use

Semitron® CMP XL20
- Significantly lower cost per wafer
- Outperforms PPS up to 20x in most processes
- High strength and stiffness promotes fewer edge defects and better uniformity

Semitron® CMP LL5
- Ideal for CMP applications up to 140°F (60°C)
- New, longer life material — up to 5x PPS
- Best performance in oxide chemistries

Techtron® PPS (Available for 300mm application only)
- The industry standard for CMP applications
- Outperforms generic PPS materials
- Excellent chemical resistance
- Consistent performance
- Very low cost in use

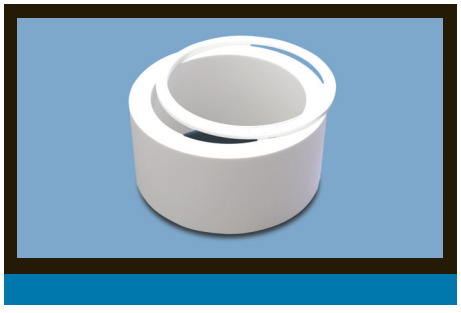
Ketron® 1000 PEEK
- Very good chemical resistance
- Longer life in oxide and slurry-less applications
- Out-performs injection molded PEEK

Ertalyte® PET-P
- Greater stability than POM
- Very good chemical resistance

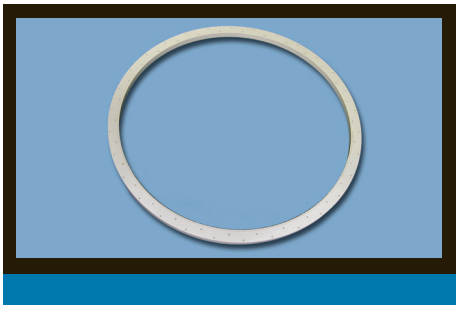
Acetron® GP
- Low-cost, consistent performance option
- Good chemical resistance

Design Tip:

Contact our development engineers for help in selecting the optimum material for components in your CMP process. Our in-house testing tool has run thousands of hours of simulations, in a broad range of chemistries. Tap into the resources at 1-800-366-0300 or www.quadrantplastics.com.



Semitron® CMP LL5 Retaining Ring and Tubular machining stock



Techtron® PPS 300mm Retaining Ring

Semitron® CMP XL20 Retaining Rings and Tubular machining stock

Just as with other process areas within a fab, materials for assembly, test and package are most effective when matched properly to the process environment. Quadrant materials have become standards in this area, and new grades continue to evolve with the needs of the industry. Tailored for these applications, our materials maintain precise tolerances and strength across a broad temperature range, manage electrostatic charges effectively and machine readily. Products are now available to handle decreased device size, increased pin count, and smaller pitch size and to deliver conductive, resistive, or highly resistive electrical performance across a broad temperature range. Quadrant's engineering team can help you select materials for these complex application requirements. Call 1-800-366-0300 or visit **www.quadrantplastics.com.**

Materials Overview

Torlon® 5530 PAI
- The industry standard for test fixture components
- Best tolerance control and highest strength over a wide temperature range
- Electrically insulative
- Low cost in use

Torlon® 4203 PAI
- Exceptional temperature resistance (to nearly 500°F)
- Ideal for thin wall designs where greater toughness is needed
- Electrically insulative

Ultem® 1000 PEI
- Low–cost, insulative performance option
- Good thermal performance in higher humidity environments

Enhanced Static Management Materials

Semitron® ESd 225 (POM)
- Dissipative material 10^9 - 10^{10} ohms per square
- Economical material ideal for handling and fixturing up to 225° F (107° C)
- Good wear resistance and easily machined

Semitron® ESd 520HR (PAI)
- Combines Torlon's exceptional strength and stability with tightly controlled electrical properties
- Dissipative material (10^{10} –10^{12} ohms per square)

Semitron® ESd 480 (PEEK)
- Good strength and stiffness, with good ESd performance
- An ideal material for applications where the environment cannot be controlled

Semitron® ESd 490HR (PEEK)
- A slightly higher resistivity PEEK based material that offers similar physical properties as Semitron ESd 480
- Dissipative material (10^{10} –10^{12} ohms per square)

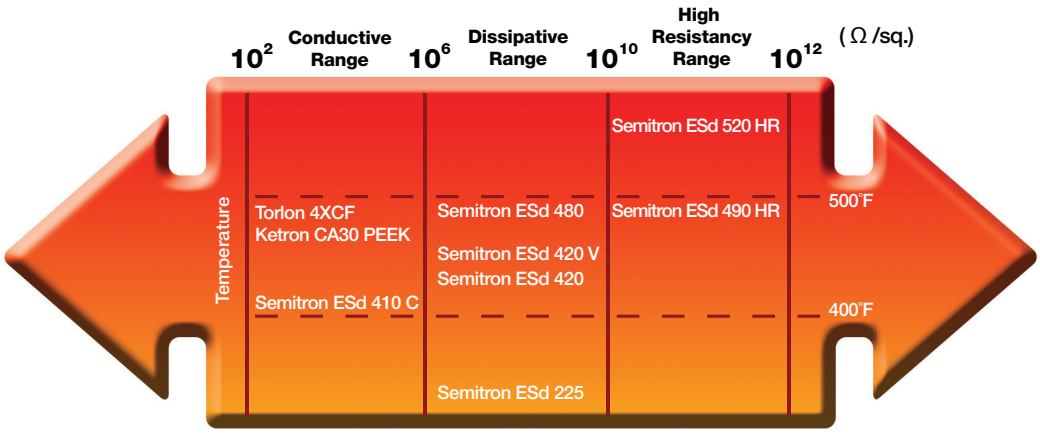
Semitron® ESd 420V (PEI)
- Dissipative material for applications requiring greater stiffness than Semitron ESd 420 (10^6 –10^9 ohms per square)

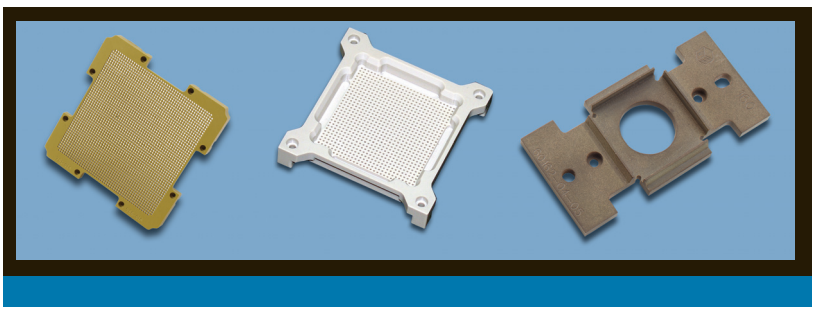
- Offers an excellent balance of performance benefits—high strength and stiffness across a broad temperature range, with low moisture absorption

Semitron® ESd 420 (PEI)
- Similar to Semitron ESd 410C with more controlled removal of static charges

Semitron® ESd 410C (PEI)
- Electrically conductive (10^4–10^6 ohms per square)
- Low moisture absorption, high strength and stiffness

ESd Performance vs. Temperature





Torlon® 4203 PAI, Ketron® 1000 PEEK, and Semitron® ESd 520 HR Test Fixtures

Design Tip:

Most ESd plastics are electrically unstable and suffer irreversible failure due to dielectric breakdown. Quadrant's Semitron products are electrically stable and do not change after repeated exposure. All of the Semitron materials are homogeneous and volumetrically resistive.

PRODUCT COMPARISON CHART

					Formulated for Broad Use				
		Units	Test Method ASTM	Acetron® GP	Ertalyte® PET-P	Techtron® PPS	Ketron® 1000 PEEK	Ultem® 1000
	Product Description			Premium Porosity-free POM-C	Semi-crystalline PET	Premium Unfilled PPS	Unfilled PEEK	Unfilled PEI
				Extruded	Extruded	Extruded	Extruded	Extruded
MECHANICAL	1 Specific Gravity, 73°F.	-	D792	1.41	1.41	1.35	1.31	1.28
	2 Tensile Strength, 73°F.	psi	D638	9,500	12,400	13,500	16,000	16,500
	3 Tensile Modulus of Elasticity, 73°F.	psi	D638	400,000	460,000	500,000	630,000	500,000
	4 Tensile Elongation (at break), 73°F.	%	D638	30	20	15	40	80
	5 Flexural Strength, 73°F.	psi	D790	12,000	18,000	21,000	25,000	20,000
	6 Flexural Modulus of Elasticity, 73°F.	psi	D790	400,000	490,000	575,000	600,000	500,000
	7 Shear Strength, 73°F.	psi	D732	8,000	8,000	9,000	8,000	15,000
	8 Compressive Strength, 10% Deformation, 73°F.	psi	D695	15,000	15,000	21,500	20,000	22,000
	9 Compressive Modulus of Elasticity, 73°F.	psi	D695	400,000	420,000	430,000	500,000	480,000
	10 Hardness, Rockwell, Scale as noted, 73°F.	-	D785	M88 (R120)	M93 (R125)	M95 (R125)	M100 (R126)	M112 (R125)
	11 Hardness, Durometer, Shore "D" Scale, 73°F.	-	D2240	D85	D87	D85	D85	D86
	12 Izod Impact (notched), 73°F.ft. lb./in. of notch	ft. lb./in. of notch	D256 Type "A"	1	0.5	0.6	1	0.5
	13 Coefficient of Friction (Dry vs. Steel) Dynamic	-	QTM 55007	0.25	0.2	0.4	0.4	0.42
	14 Limiting PV (with 4:1 safety factor applied)	ft. lbs./in.^{2} min	QTM 55007	2,700	2,800	3,000	8,500	1,875
	15 Wear Factor "k" x 10^{-10}	in.^{3}-min/ft. lbs. hr.	QTM 55010	200	60	2,400	375	2,900
THERMAL	16 Coefficient of Linear Thermal Expansion (-40°F to 300°F)	in./in./°F	E-831 (TMA)	5.4 x 10^{-5}	3.3 x 10^{-5}	2.8 x 10^{-5}	2.6 x 10^{-5}	3.1 x 10^{-5}
	17 Heat Deflection Temperature 264 psi	°F	D648	220	240	250	320	400
	18 Tg-Glass transition (amorphous)	°F	D3418	N/A	N/A	N/A	N/A	410
	19 Melting Point (crystalline) peak	°F	D3418	335	491	540	644	N/A
	20 Continuous Service Temperature in Air (Max.) (1)	°F	-	180	210	425	480	340
	21 Thermal Conductivity	BTU in./hr. ft.^{2} °F	F433	1.6	2	2	1.75	0.85
ELECTRICAL	22 Dielectric Strength, Short Term	Volts/mil	D149	420	385	540	480	830
	23 Surface Resistivity	ohm/square	EOS/ESD S11.11	>10^{13}	>10^{13}	>10^{13}	>10^{13}	>10^{13}
	24 Dielectric Constant, 10^6 Hz	-	D150	3.8	3.4	3	3.3	3.15
	25 Dissipation Factor, 10^6 Hz	-	D150	0.005	0.02	0.0013	0.003	0.0013
	26 Flammability @ 3.1 mm (1⁄8 in.) **(5)**		UL 94	HB	HB	V-0	V-0	V-0
CHEMICAL (3)	27 Water Absorption Immersion, 24 Hours	% by wt.	D570 (2)	0.2	0.07	0.01	0.1	0.25
	28 Water Absorption Immersion, Saturation	% by wt.	D570 (2)	0.9	0.9	0.03	0.5	1.25
	29 Acids, Weak, acetic, dilute hydrochloric or sulfuric acid	@73°F		L	A	A	A	A
	30 Acids, Strong, conc. hydrochloric or sulfuric acid	@73°F		U	L	L	L	U
	31 Alkalies, Weak, dilute ammonia or sodium hydroxide	@73°F		A	A	A	A	A
	32 Alkalies, Strong, strong ammonia or sodium hydroxide	@73°F		U	U	A	A	U
	33 Hydrocarbons-Aromatic, benzene, toluene	@73°F		A	A	A	A	U
	34 Hydrocarbons-Aliphatic, gasoline, hexane, grease	@73°F		A	A	A	A	L
	35 Ketones, Esters, acetone, methyl ethyl ketone	@73°F		A	A	A	A	U
	36 Ethers, diethyl ether, tetrahydrofuran	@73°F		A	A	A	A	A
	37 Chlorinated Solvents, methylene chloride, chloroform	@73°F		L	U	A	A	U
	38 Alcohols, methanol, ethanol, anti-freeze	@73°F		A	A	A	A	A
	39 Continuous Sunlight	@73°F		L	L	L	L	A
OTHER	40 FDA Compliance			Y	Y	Y	Y	Y
	41 Relative Cost (4)			$	$$	$$$$	$$$$$	$$$
	42 Relative Machinability (1-10, 1=Easier to Machine)			1	2	3	5	3

(1) Data represent Quadrant's estimated maximum long-term service temperature based on practical field experience.

(2) Specimens 1/8" thick x 2" dia. or square.

(3) Chemical resistance data are for little or no applied stress. Increased stress, especially localized, may result in more severe attack. Examples of common chemicals also included.

(4) Relative cost of material profiled in this brochure ($ = Least Expensive and $$$$$$ = Most Expensive)

(5) **Estimated rating based on available data.** The UL 94 Test is a laboratory test and does not relate to actual fire hazard. Contact Quadrant for specific UL "Yellow Card" recognition number.

Key
A = Acceptable Service
L = Limited Service
U = Unacceptable
QTM = Quadrant Test Method

NOTE: Property data shown are typical average values. A dash (-) indicates insufficient data available for publishing.

	Formulated for Dry Process Applications		Formulated for Wet Process Applications		Formulated for CMP Applications		Formulated for Static Management Applications				
	Ketron® UHP320 PEEK	Celazole® PBI	Symalit ECTFE	Symalit PVDF	Semitron® CMP LL5	Semitron® CMP XL20	Semitron® ESd 225	Semitron® ESd 410C	Semitron® ESd 420	Semitron® ESd 420V	Semitron® ESd 480
	Ultra-high Purity PEEK	Unfilled PBI	Unfilled ECTFE	Unfilled PVDF	Enhanced PET-P	Enhanced PAI	Static Dissipative POM	Static Dissipative PEI	Static Dissipative PEI	Static Dissipative PEI	Static Dissipative PEEK
	Extruded	Compression Molded	Extruded	Extruded	Extruded	Extruded	Extruded	Compression Molded	Compression Molded	Compression Molded	Compression Molded
1	1.31	1.3	1.68	1.78	1.44	1.41	1.33	1.41	1.34	1.51	1.47
2	16,000	20,000	4,500	7,000	10,500	18,000	5,400	9,000	11,500	10,000	14,500
3	500,000	850,000	240,000	300,000	500,000	600,000	200,000	850,000	640,000	910,000	940,000
4	35	3	200	100	5	10.0	15	2	2	1.5	1.5
5	25,000	32,000	7,000	8,000	14,000	24,000	7,300	12,000	14,500	15,800	21,000
6	600,000	950,000	240,000	290,000	360,000	600,000	220,000	850,000	650,000	910,000	1,000,000
7	8,000	-	-	-	8,500	16,000	6,000	9,000	8,020	-	-
8	20,000	50,000	5,000	10,000	15,250	24,000	8,000	19,500	23,800	22,300	26,500
9	500,000	900,000	-	160,000	400,000	478,000	175,000	600,000	370,000	545,000	570,000
10	M100 (R126)	E105 (M125)	-	M75	M94	E80 (M120)	M50 (R108)	M115 (R125)	M118	M110 (E78)	M107 (R122)
11	D85	D94	D75	D78	-	-	D76	D85	-	-	-
12	1.0	0.5	no break	3.0	0.4	2.0	1.5	0.8	1	0.5	1.0
13	0.4	0.24	-	-	0.19	0.35	0.29	0.18	0.28	-	0.20
14	25,000	37,500	-	-	6,000	12,500	2,000	12,000	9,500	-	17,000
15	-	60	-	-	35	50	30	125	100	-	-
16	2.6×10^{-5}	1.3×10^{-5}	6.6×10^{-5}	6.6×10^{-5}	4.5×10^{-5}	1.7×10^{-5}	9.3×10^{-5}	1.8×10^{-5}	1.95×10^{-5}	1.5×10^{-5}	1.7×10^{-5}
17	320	800 (DMA)	170	230	180	532	225	410	410	420	500
18	N/A	750 (DMA)	N/A	N/A	N/A	527	N/A	410	410	420	N/A
19	644	N/A	464	340	491	N/A	320	N/A	N/A	N/A	644
20	480	600	300	300	210	500	180	338	340	340	475
21	1.75	2.8	-	1.5	1.9	1.80	-	2.45	1.51	-	-
22	480	550	500	260	-	580	-	N/A	-	-	-
23	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{16}$	$10^{9} - 10^{10}$	$10^{4} - 10^{6}$	$10^{6} - 10^{9}$	$10^{6} - 10^{9}$	$10^{6} - 10^{9}$
24	3.3	3.2	2.5	6.4	3.6	4.2	4.31	3	5.63	-	10.9
25	0.003	0.003	0.003	0.165	0.02	0.026	.036	0.0013	.266	-	.518
26	V-0	V-0	V-0	V-0	HB	V-0	HB	V-0	V-0	V-0	V-0
27	0.10	0.4	<.01	.03	0.06	0.4	2	0.3	0.5	0.21	0.18
28	0.50	5	-	.05	0.47	1.7	8	1.1	2.9	1.4	1.65
29	A	L	A	A	A	A	L	A	A	A	A
30	L	U	A	L	L	L	U	U	U	U	L
31	A	L	A	L	A	L	A	A	A	A	A
32	A	U	A	U	U	U	U	U	U	U	A
33	A	A	A	A	A	A	A	U	U	U	A
34	A	A	A	A	A	A	A	L	L	L	A
35	A	A	U	U	A	A	A	U	U	U	A
36	A	A	L	L	A	A	A	A	A	A	A
37	A	A	L	L	U	A	L	U	U	U	A
38	A	A	A	A	A	A	A	A	A	A	A
39	L	L	L	L	L	L	L	A	A	A	A
40	N	N	N	Y	N	N	N	N	N	N	N
41	$$$$$	$$$$$	$	$	$$$	$$$$$	$$	$$$$	$$$$$	$$$$$	$$$$$
42	5	10	3	3	2	5	1	4	4	4	4

PRODUCT COMPARISON CHART

					Formulated for Static Management Applications		Formulated for Test/Package Applications	
		Units	Test Method ASTM	Semitron® ESd 490 HR	Semitron® ESd 520HR	Torlon® 5530	Torlon® 4203
	Product Description			Static Dissipative PEEK	Static Dissipative PAI	30% Glass Filled PAI	Electrical Grade PAI
				Compression Molded	Compression Molded	Compression Molded	Extruded
MECHANICAL	1	Specific Gravity, 73°F.	-	D792	1.50	1.58	1.61	1.41
	2	Tensile Strength, 73°F.	psi	D638	14,000	12,000	15,000	20,000
	3	Tensile Modulus of Elasticity, 73°F.	psi	D638	940,000	800,000	900,000	600,000
	4	Tensile Elongation (at break), 73°F.	%	D638	2.3	3%	3	10
	5	Flexural Strength, 73°F.	psi	D790	21,000	20,000	20,000	24,000
	6	Flexural Modulus of Elasticity, 73°F.	psi	D790	950,000	850,000	900,000	600,000
	7	Shear Strength, 73°F.	psi	D732	-	12,600	-	16,000
	8	Compressive Strength, 10% Deformation, 73°F.	psi	D695	26,000	30,000	27,000	24,000
	9	Compressive Modulus of Elasticity, 73°F.	psi	D695	600,000	600,000	600,000	478,000
	10	Hardness, Rockwell, Scale as noted, 73°F.	-	D785	R123 (M105)	M108	E85 (M125)	E80 (M120)
	11	Hardness, Durometer, Shore "D" Scale, 73°F.	-	D2240	-	-	D90	-
	12	Izod Impact (notched), 73°F.ft. lb./in. of notch	ft. lb./in. of notch	D256 Type "A"	1.0	0.8	0.7	2
	13	Coefficient of Friction (Dry vs. Steel) Dynamic	-	QTM 55007	0.20	0.24	0.2	0.35
	14	Limiting PV (with 4:1 safety factor applied)	ft. lbs./in.^{2} min	QTM 55007	17,000	27,000	20,000	12,500
	15	Wear Factor "k" x 10^{-10}	in.^{3}-min/ft. lbs. hr.	QTM 55010	-	300	-	50
THERMAL	16	Coefficient of Linear Thermal Expansion (-40°F to 300°F)	in./in./°F	E-831 (TMA)	2.8 x 10^{-5}	2.8 x 10^{-5}	2.6 x 10^{-5}	1.7 x 10^{-5}
	17	Heat Deflection Temperature 264 psi	°F	D648	500	520	520	532
	18	Tg-Glass transition (amorphous)	°F	D3418	-	527	527	527
	19	Melting Point (crystalline) peak	°F	D3418	644	N/A	N/A	N/A
	20	Continuous Service Temperature in Air (Max.) (1)	°F	-	475	500	500	500
	21	Thermal Conductivity	BTU in./hr. ft.^{2} °F	F433	-	2.6	2.5	1.8
ELECTRICAL	22	Dielectric Strength, Short Term	Volts/mil	D149	-	475	700	580
	23	Surface Resistivity	ohm/square	EOS/ESD S11.11	10^{10}-10^{12}	10^{10} - 10^{12}	>10^{13}	>10^{16}
	24	Dielectric Constant, 10^6 Hz	-	D150	5.33	5.76	6.3	4.2
	25	Dissipation Factor, 10^6 Hz	-	D150	.227	0.182	0.05	0.026
	26	Flammability @ 3.1 mm (1⁄8 in.) **(5)**		UL 94	V-0	V-0	V-0	V-0
CHEMICAL (3)	27	Water Absorption Immersion, 24 Hours	% by wt.	D570 (2)	0.18	0.6	0.3	0.4
	28	Water Absorption Immersion, Saturation	% by wt.	D570 (2)	1.65	4.6	1.5	1.7
	29	Acids, Weak, acetic, dilute hydrochloric or sulfuric acid	@73°F		A	A	A	A
	30	Acids, Strong, conc. hydrochloric or sulfuric acid	@73°F		L	L	L	L
	31	Alkalies, Weak, dilute ammonia or sodium hydroxide	@73°F		A	L	L	L
	32	Alkalies, Strong, strong ammonia or sodium hydroxide	@73°F		A	U	U	U
	33	Hydrocarbons-Aromatic, benzene, toluene	@73°F		A	A	A	A
	34	Hydrocarbons-Aliphatic, gasoline, hexane, grease	@73°F		A	A	A	A
	35	Ketones, Esters, acetone, methyl ethyl ketone	@73°F		A	A	A	A
	36	Ethers, diethyl ether, tetrahydrofuran	@73°F		A	A	A	A
	37	Chlorinated Solvents, methylene chloride, chloroform	@73°F		A	A	A	A
	38	Alcohols, methanol, ethanol, anti-freeze	@73°F		A	A	A	A
	39	Continuous Sunlight	@73°F		A	L	L	L
OTHER	40	FDA Compliance			N	N	N	N
	41	Relative Cost (4)			$$$$$	$$$$$	$$$$$	$$$$$
	42	Relative Machinability (1-10, 1=Easier to Machine)			4	4	8	5

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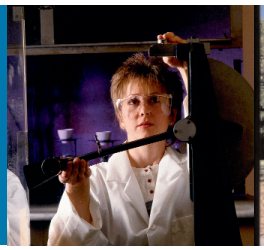

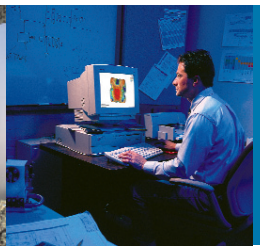

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