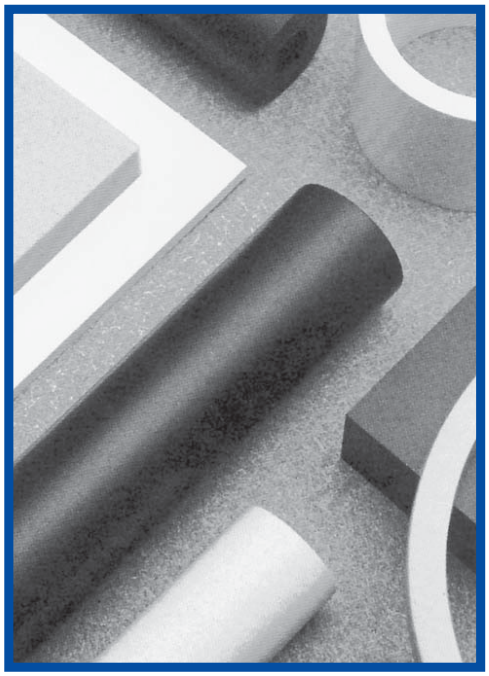
Advanced Engineering Plastics

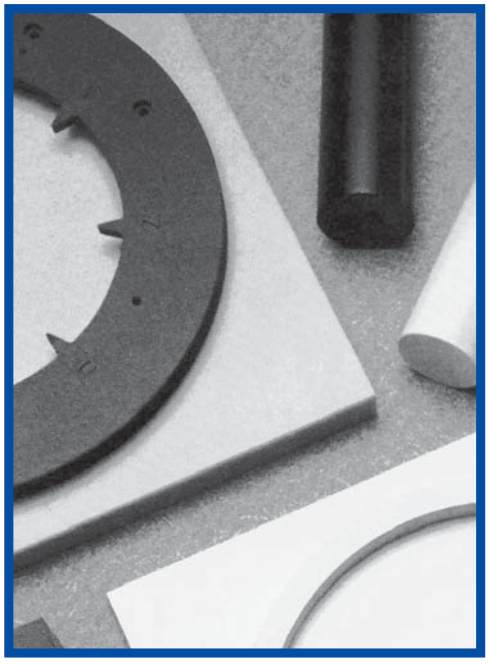
for the Semiconductor Industry

EXTREME MATERIALS

QUADRANT
ENGINEERING PLASTIC PRODUCTS

ONLY QEPP OFFERS THE SEMIC





The Broadest Product Line

Quadrant Engineering Plastic Products is the world's largest supplier of advanced engineering plastic stock shapes for machining. Machining is often the preferred manufacturing method for components in the semiconductor industry because it allows tighter tolerance control, more flexibility in design, and lower part costs for limited production runs. QEPP offers a full range of materials in rod, plate and tubular bar with temperature resistance from 200^{o}C to 800 ^{o}F(93^{o}C to 427^{o}C). Please see the chart at the back of this brochure for details on our extensive portfolio of products for the semiconductor industry.

Worldwide Supply

QEPP has manufacturing and engineering service centers in the United States, Europe, Japan and Asia - ensuring consistent quality, service and supply assurance around the world.

Accurate Data, Plus Full Traceability

QEPP is the only supplier of stock shapes that provides performance data based on testing of actual manufactured shapes. As a result, design engineers gain a more accurate picture of actual material performance. Other manufacturer's often report values based on resin supplier data generated from injection molded plaques. As a part of our commitment to quality control, all our shapes are traceable back to original raw material.

Technical Support

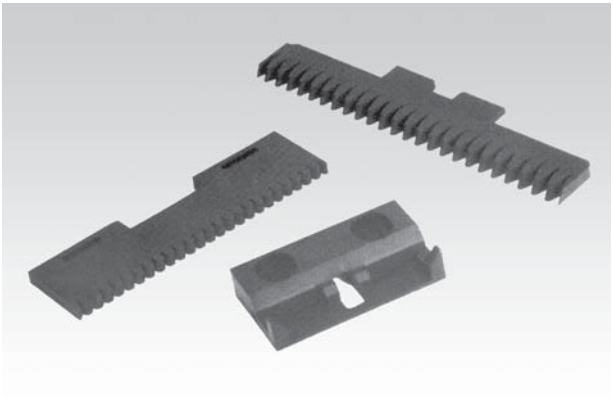
Full support in material selection and fabrication of parts is available from QEPP Engineering Plastic Products'

ONDUCTOR INDUSTRY...

New Material Solutions

These new, advanced engineering thermoplastic products have been developed to meet the diverse needs of the semiconductor industry, including:

- Electrostatic Dissipation
- Chemical Resistance
- Dimensional Stability
- High Purity
- Thermal Resistance
- Wear Resistance



Semitron® ESd 225

Static Dissipative Acetal

- Surface resistivity: 10^{10} - 10^{12} Ω/ sq.
- Thermal performance to 225 ºF (107 ºC)
- Good wear resistance

Semitron® ESd 410C

Static Dissipative PEI

- Surface resistivity: 10^{4} - 10^{6} Ω/ sq.
- Thermal performance to 410 ºF (210 ºC)
- Low stress for tight tolerance machining
- High strength and stiffness

Semitron® ESd 420

Static Dissipative PEI

- Surface resistivity: 10^{6} - 10^{9} Ω/ sq.
- Thermal performance to 420 ºF (212 ºC)

Semitron® ESd 500HR

Static Dissipative PTFE

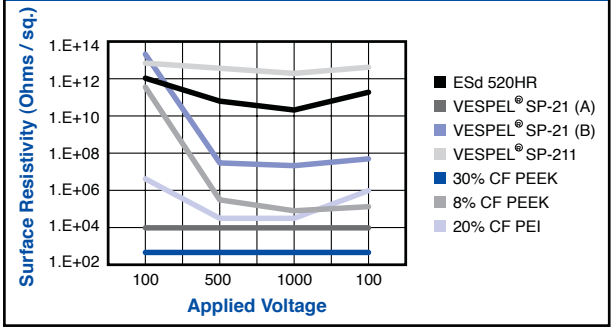
- Surface resistivity: 10^{10} - 10^{12} Ω/ sq.
- Thermal performance to 500 ºF (260 ºC)
- Thermally insulative
- Very low coefficient of friction
- Broad chemical resistance

Semitron® ESd 520HR

Static Dissipative PAI

- Surface resistivity: 10^{10} - 10^{12} Ω/ sq.
- Maintain resistivity performance throughout wide voltage range (see figure 1)
- Thermal performance to 520 ºF (271 ºC)
- Resist dielectric breakdown at high voltage (> 100V)

figure 1: Surface Resistivity



Torlon® 5530 PAI

Glass-reinforced polyamide-imide

- Thermal performance to 520 ºF (271 ºC)
- Very low coefficient of linear thermal expansion
- 1.5 x 10-15 in./in./°F (2.7 x 10-5 mm/mm/ ºC)

Duratron® XP

High purity polyimide

- Heat resistance to 575 ºF (303 ºC)
- Very low level of ionic impurities
- Minimal outgassing, even at elevated temperatures

Celazole® PBI

Unreinforced polybenimidaole

- Highest heat resistance (800 º F / 427 ºC) with excursions possible to 1,000 ºF (538 ºC)
- High purity
- Lowest coefficient of linear thermal expansion
- Highest mechanical properties of any thermoplastic

These materials, combined with QEPP Engineering Plastic Products' standard product line represent the broadest portfolio of material solutions available today. Typical applications for QEPP's products include:

- Wafer combs
- Boat inserts
- Wear guides
- Vacuum wand tips
- Thermal isolators
- Water tracks
- Handling trays
- Retaining rings
- Vacuum wand handles
- Nests and contactors
- Seal adapters
- Windows

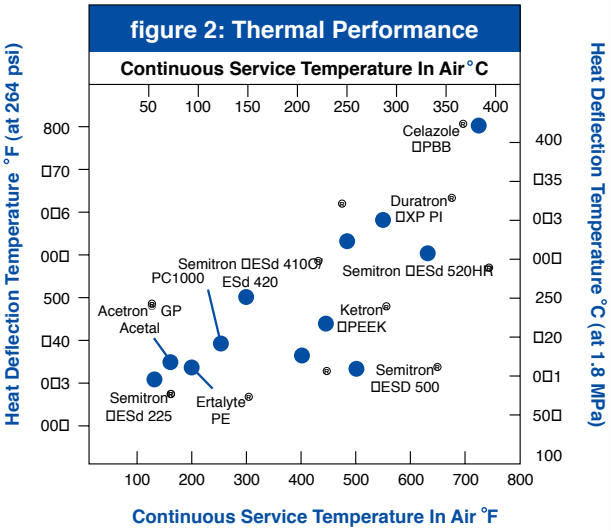
WAFER MANUFACTURING COMP

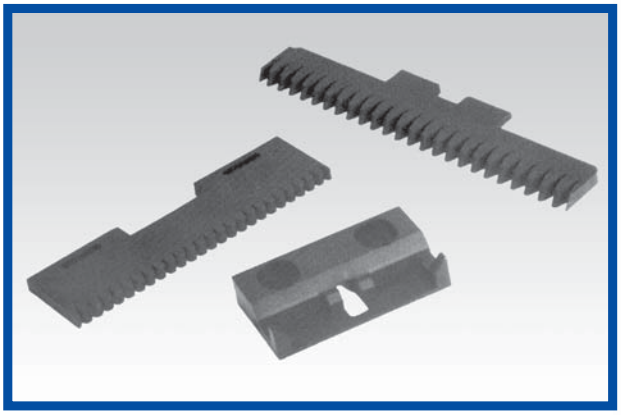
In wafer manufacturing, high temperatures and exposure to aggressive chemicals dictate the use of the most advanced thermoplastics available today. Purity is also a critical concern.

Products like Celazole® polybenzimidazole and Duratron® XP polyimide have very low levels of ionic impurities, making them safe for use in applications that directly contact wafer surfaces. Duratron® XP offers dimensional stability, chemical resistance, and retains its strength at high process temperatures. When process temperatures exceed 575 °F(303°C), Quadrant Engineering Plastic Products' Celazole® PBI stock shapes are the optimum choice. **Celazole® is the highest temperature thermoplastic available today.** Celazole can operate in mechanical applications up to 800°F (427°C), with excursions possible to 1,000°F (538°C).

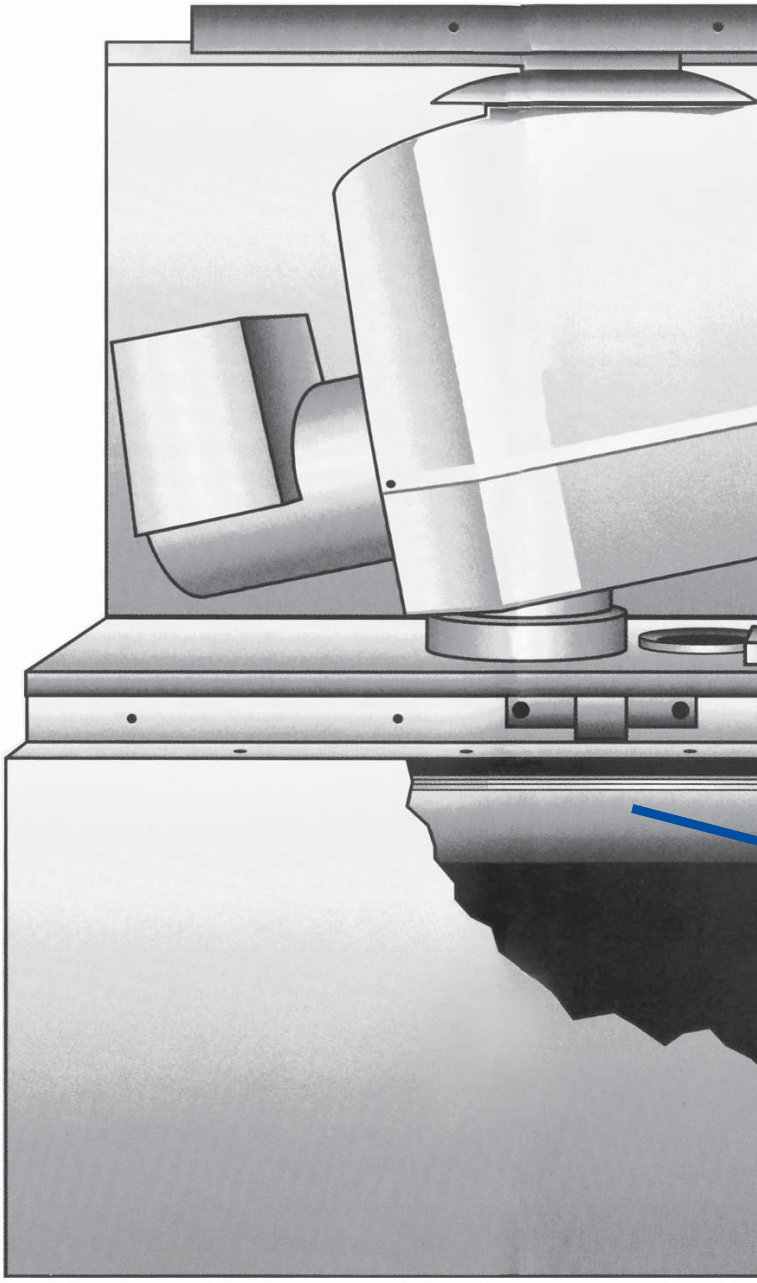
Figure 2 shows the broad thermal range over which QEPP's most popular materials for the semiconductor industry perform.

figure 2: Thermal Performance





Retainers, valve caps and locators manufactured from Duratron® XP polyimide have the purity and thermal stability needed to excel in applications on hot wafer handling equipment.



ONENTS

In chemical-mechanical polishing, chemical agents and abrasives work jointly on the wafer surface to produce a mirror finish. Techtron® PPS or Ketron® PEEK are used as holding rings that retain wafers during polishing. Techtron PPS and Ketron® PEEK withstand the chemical and mechanical stresses present during polishing. The water driven track system is manufactured from Ertalyte® PET-P, due to its high purity.

Retaining rings used to retain wafers in chemical-mechanical polishing(CMP) equipment are fabricated from Techtron® PPS or Ketron ®PEEK plate

Ertalyte® PET-P is used for wafer tracks that transport wafers through the chemical mechanical polishing process.

WAFER PROCESSING COMPONE

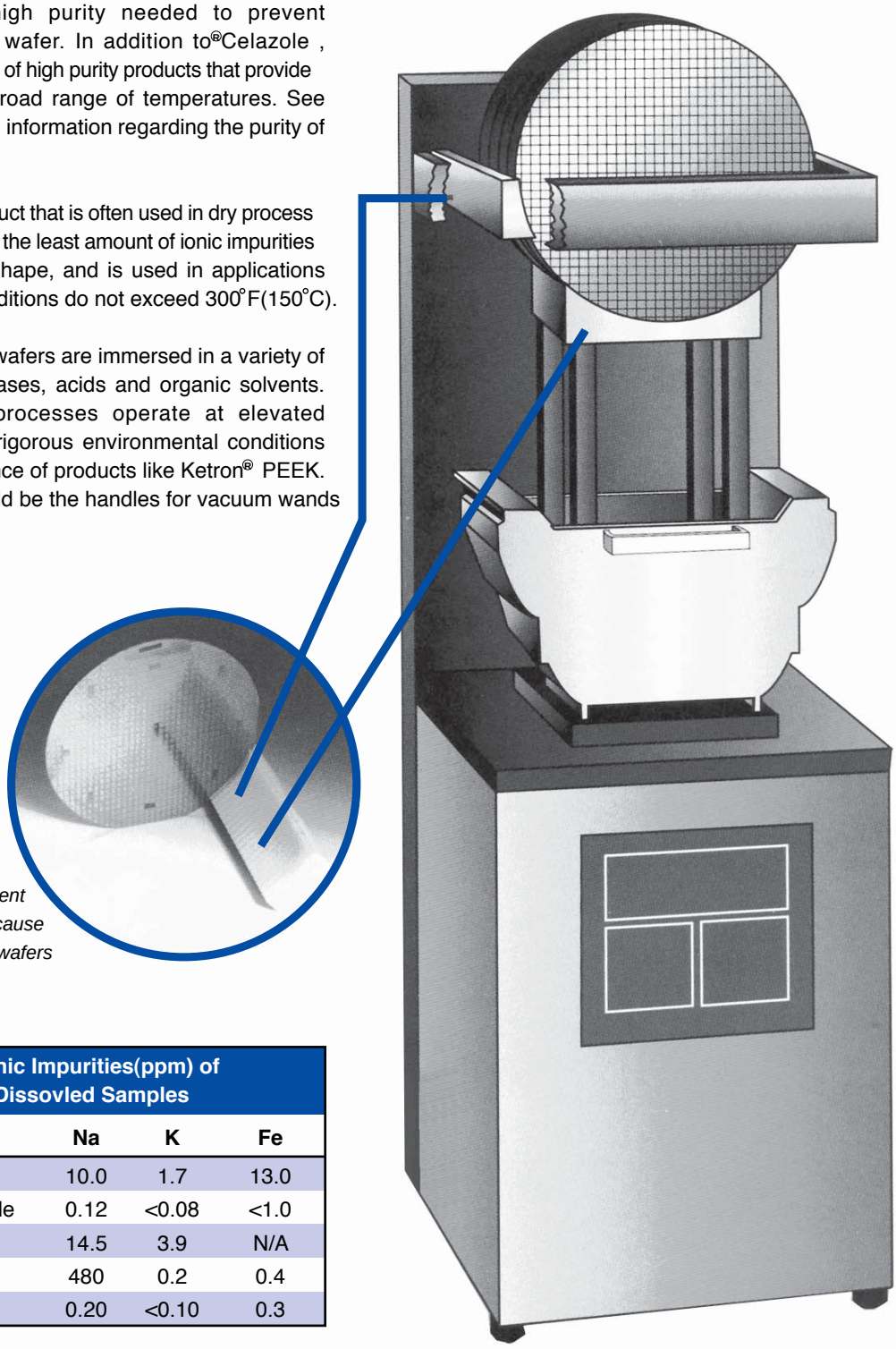
In wafer processing most environments are characterized by high temperatures, aggressive chemicals and the need for very high purity.

In dry processing (i.e. gas plasma etching and stripping), the high temperatures and exposure to aggressive gas plasma, requires the use of Celazole®polybenzimidazole. In applications that directly contact the wafer surface, Celazole has the high purity needed to prevent contamination of the wafer. In addition to®Celazole , Quadrant offers a series of high purity products that provide performance over a broad range of temperatures. See Tables I and II for more information regarding the purity of QEPP's products.

PC1000 is another product that is often used in dry process chambers. PC1000 has the least amount of ionic impurities of any thermoplastic shape, and is used in applications where the thermal conditions do not exceed 300˚F(150˚C).

In the wet processes, wafers are immersed in a variety of chemicals including bases, acids and organic solvents. Often times these processes operate at elevated temperatures. These rigorous environmental conditions demand the performance of products like Ketron® PEEK. A typical example would be the handles for vacuum wands which must have strength and heat resistance, as well as resistance to various chemicals. QEPP's advanced engineering thermoplastic products provide solutions for a variety of chemical environments as shown in Table III.

Many handling applications require the use of static dissipative products to protect the wafers from static discharge. Examples of such applications are the



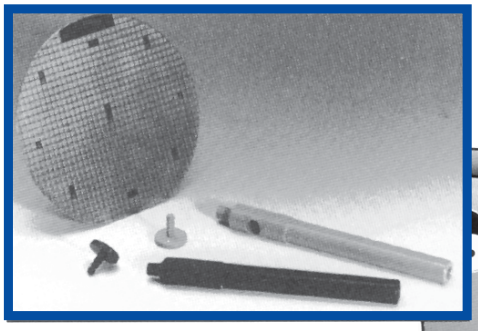
Wafer combs made of static dissipative Semitron® ESd 225 eliminate transfer equipment discharge problems that cause millions of dollars in lost wafers every year.

Table I : Ionic Impurities(ppm) of Totally Dissovled Samples

	Na	K	Fe
Celazole® PBI	10.0	1.7	13.0
Duratron® XP Polyimide	0.12	<0.08	<1.0
Torlon®4203	14.5	3.9	N/A
Ketron®PEEK	480	0.2	0.4
PC1000	0.20	<0.10	0.3

combs on wafer boat transfer equipment. Electrical shock due to static discharge can confuse the transfer equipment and damage the wafers. Combs manufactured from Semitron® ESd 225 dissipate static charges in a controlled manner.

QEPP Engineering Plastic Products offers a family of static dissipative Semitron products, that provide varying levels of protection against static electricity, as seen in Table IV



Ketron® PEEK is used for vacuum wand handles since they typically contact heat and common process chemicals in use.

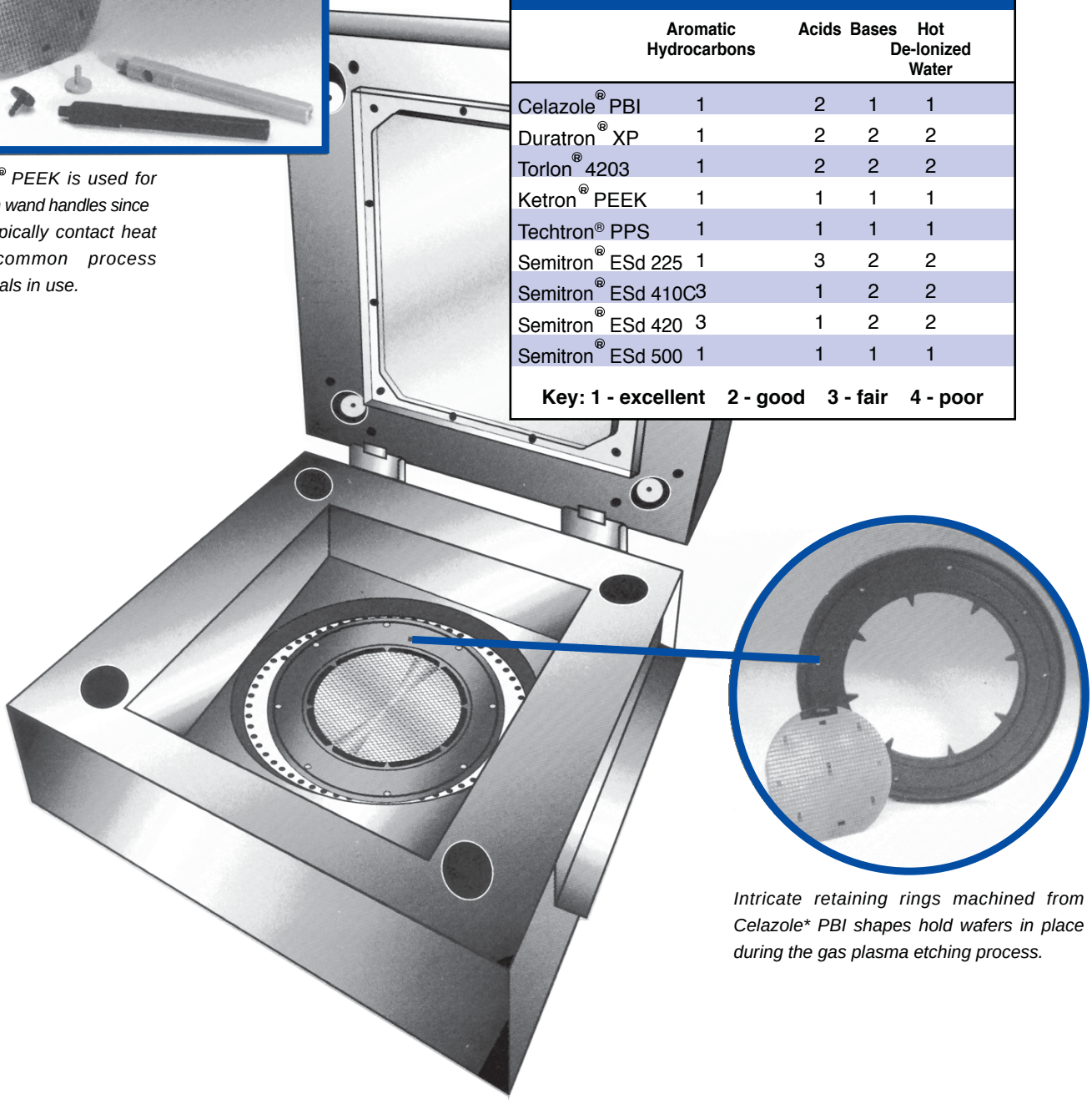
Table II : Outgassing

	Total Mass Loss %	Collected Volatile Condensed Material, %	Water Vapor Recovered %
Celazole® PBI	2.50	0.00	0.40
Duratron® XP Polyimide	0.75	0.00	0.49
Torlon® 4203	1.85	0.00	0.49
Ketron® PEEK	0.31	0.00	0.16
PC1000	0.03	0.00	0.04

Table III : Resistance to Chemicals

	Aromatic Hydrocarbons	Acids	Bases	Hot De-Ionized Water
Celazole® PBI	1	2	1	1
Duratron® XP	1	2	2	2
Torlon® 4203	1	2	2	2
Ketron® PEEK	1	1	1	1
Techtron® PPS	1	1	1	1
Semitron® ESd 225	1	3	2	2
Semitron® ESd 410C	3	1	2	2
Semitron® ESd 420	3	1	2	2
Semitron® ESd 500	1	1	1	1

Key: 1 - excellent 2 - good 3 - fair 4 - poor



Intricate retaining rings machined from Celazole PBI shapes hold wafers in place during the gas plasma etching process.*

ASSEMBLY, PACKAGING & TEST

Thermal and dimensional stability and static dissipation are typical requirements for components in back end test equipment. QEPP offers a variety of products that are ideal for use in these components.

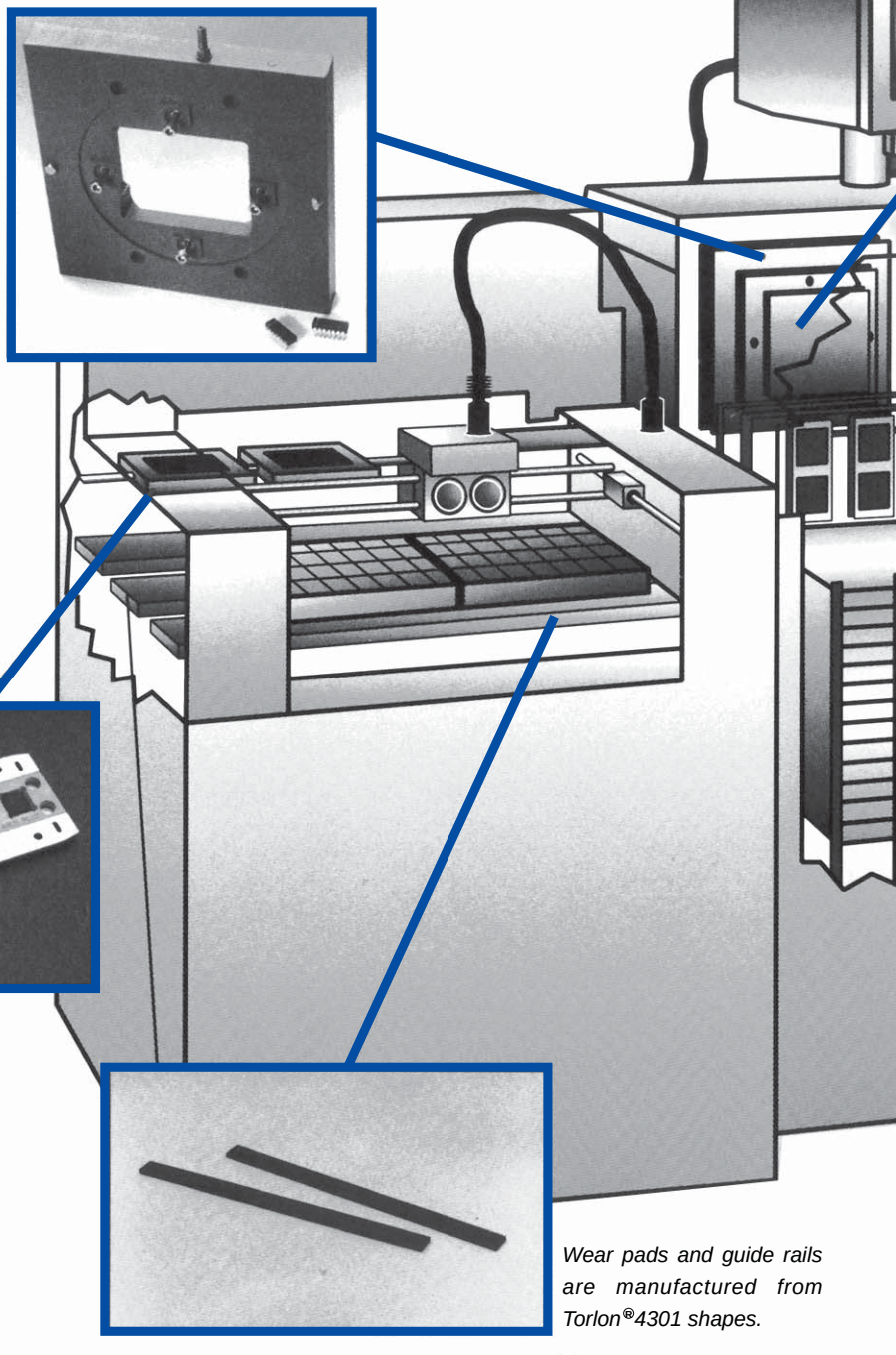
Torlon®5530 is very dimensionally stable over the broad range of test temperatures (-55° C to 150°C). Strength and dimensional stability make Torlon®5530 the ideal material for use in nests and sockets, lasting up to six times longer than traditional materials. (Refer to Figure 3 for more information regarding the coefficient of linear thermal expansion (CLTE) of selected QEPP products.)

A special formulated static-dissipative Torlon PAI products, namely **Semitron® ESd 520HR** which features the mechanical properties of Torlon®5530 plus static-dissipative characteristic, was developed for the growing demand on static-dissipative requirement in the back end test

Semitron® ESd 500 is ideal for thermal isolation, where static dissipation is required. It is the only product available which combines high temperature stability, thermal insulation, static dissipation and is non-sloughing.

Semitron®ESd 410C / ESd 420 is used in device handling applications where controlled dissipation of static charges is critical.

Additional grades of Torlon®PAI are excellent choices for semiconductor test applications such as guide rails, wear strips and seal adapters.

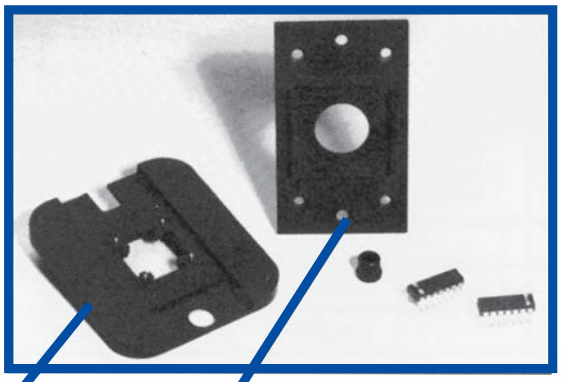


Seal adapters on test equipment machined from Torlon®4203 plate provide longer part life and tighter seal fit.

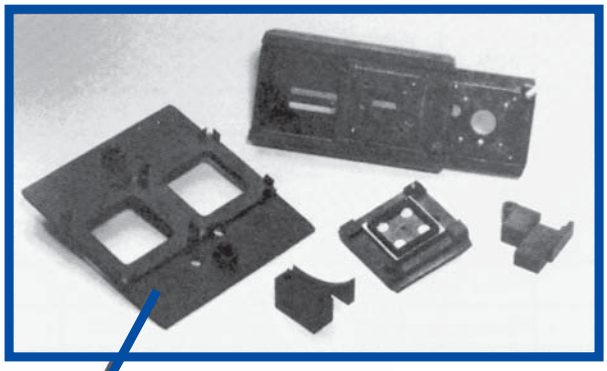
Static dissipative inserts machined from Semitron®ESd 500 plate reduce damage to sensitive devices due to static discharge.

Wear pads and guide rails are manufactured from Torlon®4301 shapes.

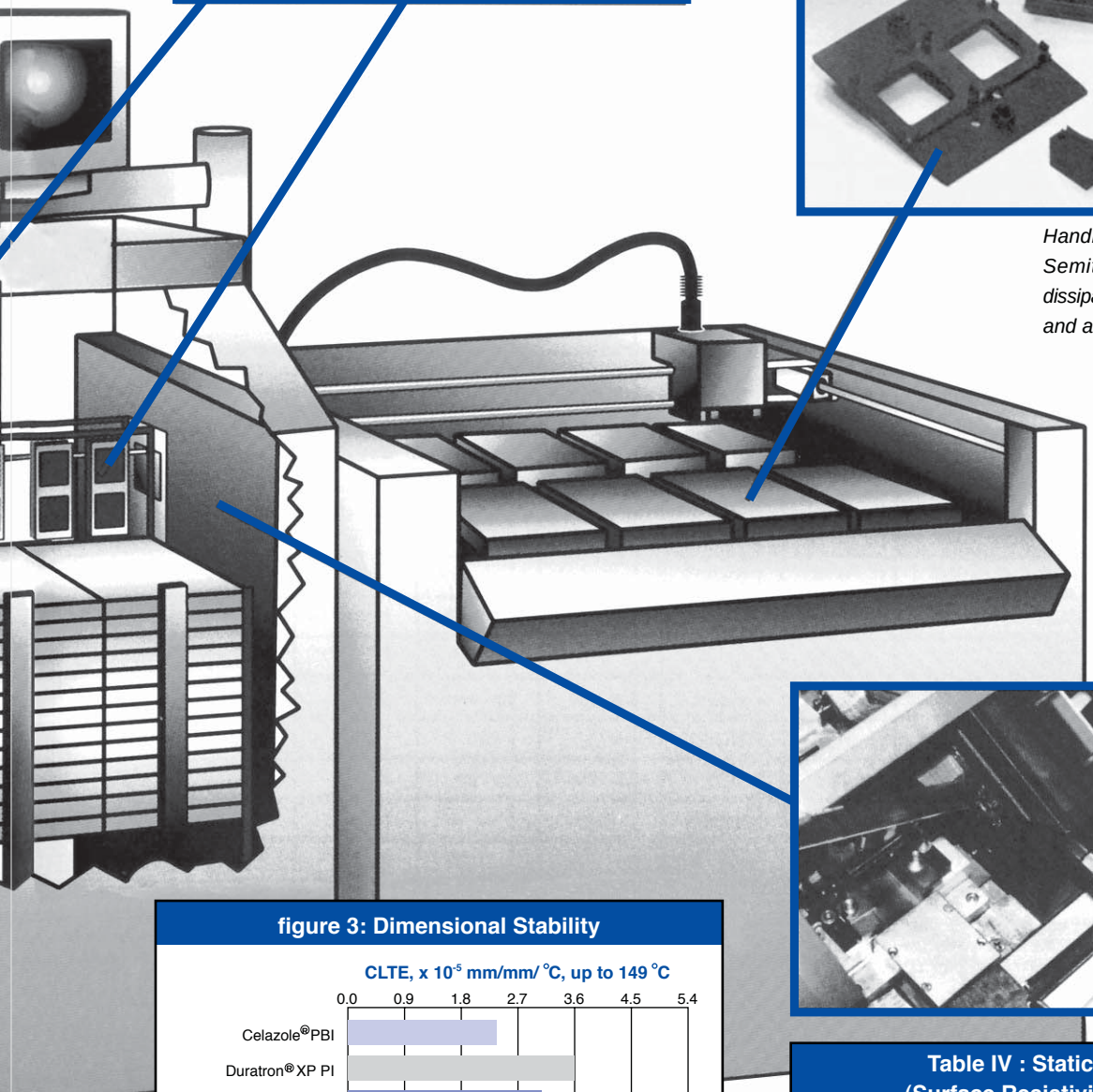
COMPONENTS



Nests and contactors made of glass fiber reinforced Torlon® 5530 PAI plate provide highly reliable results, fewer device rejects, and last up to six times longer than traditional polyimide materials. For static sensitive device, Semitron® ESd 520HR is recommended



Handling trays manufactured from Semitron® ESd 410C / ESd 420 dissipate static charges more reliably and are more dimensionally stable.



Insulating blocks made from Semitron® ESd 500 plate dissipate static electricity reliably in test handling equipment, replacing costly anti-static coating requirements and improving device yields.

figure 3: Dimensional Stability

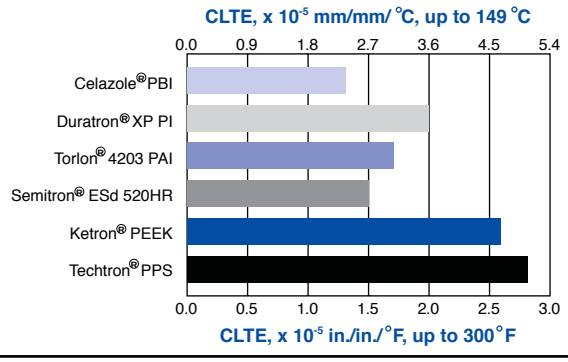


Table IV : Static Dissipation (Surface Resistivity, ohms / sq.)

Semitron® ESd 225	10^{10} - 10^{12}
Semitron® ESd 410C	10^{4} - 10^{6}
Semitron® ESd 420	10^{6} - 10^{9}
Semitron® ESd 500	10^{10} - 10^{12}
Semitron® ESd 520HR	10^{10} - 10^{12}

PRODUCT COMPARISON

		Product Description	Unit	Test Method ASTM	Semitron® ESd 225	Semitron® ESd 410C	Semitron® ESd 420	Semitron® ESd 500HR	Semitron® ESd 520HR
					Static Dissipative Acetal	Static Dissipative Polyetherimide	Static Dissipative Polyethersulfide	Static Dissipative PTFE	Static Dissipative Polyetherimide
MECHANICAL	1	Specific Gravity, 73°F	-	D792	1.33	1.41	1.45	2.30	1.58
	2	Tensile Strength, 73°F.	psi	D638	5,400	9,000	9,500	1,500	12,000
	3	Tensile Modulus of Elasticity, 73°F	psi	D638	200,000	850,000	550,000	250,000	800,000
	4	Tensile Elongation (at break), 73°F	%	D638	15	2.0	2	50	3%
	5	Flexural Strength, 73°F	psi	D790	7,300	12,000	14,500	2,200	20,000
	6	Flexural Modulus of Elasticity, 73°F	psi	D790	220,000	850,000	525,000	350,000	850,000
	7	Shear Strength, 73°F	psi	D732	6,000	9,000	7,300	1,700	12,600
	8	Compressive Strength, 10% Deformation, 73°F	psi	D695	8,000	19,500	16,500	3,800	30,000
	9	Compressive Modulus of Elasticity, 73°F	psi	D695	175,000	600,000	350,000	225,000	600,000
	10	Hardness, Rockwell, Scale as noted, 73°F	-	D785	M50 (R108)	M115 (R125)	M87	R50	M108
	11	Hardness, Durometer, Shore "D" Scale, 73°F	-	D2240	D76	D85	-	D65	-
	12	Izod Impact (notched), 73°F	ft. lb.ln. of notch	D256 Type "A"	1.5	0.8	1.0	1.0	0.8
	13	Coefficient of Friction (Dry vs. Steel) Dynamic	-	PTM 55007	0.29	0.18	0.2	0.1	0.24
	14	Limiting PV (with 4:1 safety factor applied)	ft. lbs./in.^{2} min	PTM 55007	2,000	12,000	25,000	6,000	27,000
	15	Wear Factor "k" x 10^{-10}	in.^{3}-min/ft. lbs. hr.	PTM 55010	30	125	50	30	300
THERMAL	16	Coefficient of Linear Thermal Expansion (-40°F to 300°F)	in./in./°F	E-831 (TMA)	9.30 x 10^{-5}	1.80x 10^{-5}	3.2 x 10^{-5}	5.70 x 10^{-5}	1.5 x 10^{-5}
	17	Heat Deflection Temperature 264 psi	°F	D648	225	410	420	210	520
	18	Tg-Glass transition (amorphous)	°F	D3418	N/A	428	205	N/A	527
	19	Melting Point (crystalline) peak	°F	D3418	320	N/A	-	621	N/A
	20	Continuous Service Temperature in Air (Max.) (1)	°F	-	180	338	340	500	500
	21	Thermal Conductivity	BTU in./hr. ft.^{2} °F	F433	-	2.45	1.60	-	2.48
ELECTRICAL	22	Dielectric Strength, Short Term	Volts/mil	D149	-	N/A	-	-	-
	23	Surface Resistivity	ohm/square	EOS/ESD S11.11	10^{10} - 10^{12}	10^4 - 10^6	10^6 - 10^9	10^{10} - 10^{12}	10^{10} - 10^{12}
	24	Dielectric Constant, 106 Hz	-	D150	-	3.0	-	-	5.76
	25	Dissipation Factor, 106 Hz	-	D150	-	0.0013	-	-	1.82
	26	Flammability @ 3.1 mm (1B in.) (5)	-	UL 94	HB	V-O	V-O	V-O	V-0
CHEMICAL (3)	27	Water Absorption Immersion, 24 Hours	% by wt.	D570 (2)	2.0	0.01	0.80	0.03	0.60
	28	Water Absorption Immersion, Saturation	% by wt.	D570 (2)	8.0	0.03	2.60	2.0	4.6
	29	Acids, Weak, 73°F, acetic acid, dilute hydrochloric or sulfuric acid			L	A	-	A	A
	30	Acids, Strong, 73°F, conc. hydrochloric or sulfuric acid			U	L	U	A	L
	31	Alkalies, Weak, 73°F, dilute ammonia or sodium hydroxide			A	A	A	A	L
	32	Alkalies, Strong, 73°F, strong ammonia or sodium hydroxide			U	A	U	A	U
	33	Hydrocarbons-Aromatic, 73°F, benzene, toluene			A	A	-	A	A
	34	Hydrocarbons-Aliphatic, 73°F, gasoline, hexane, grease			A	A	-	A	A
	35	Ketones, Esters, 73°F, acetone, methyl ethyl ketone			A	-	U	A	A
	36	Ethers, 73°F, diethyl ether, tetrahydrofuran			A	-	-	A	A
	37	Chlorinated Solvents, 73°F, methylene chloride, chloroform			L	-	-	A	A
	38	Alcohols, 73°F, methanol, ethanol, anti-freeze			A	A	-	A	-
	39	Inorganic Salt Solutions, 73°F, sodium chloride, potassium cyanate			A	A	-	A	A
	40	Continuous Sunlight, 73°F			L	-	-	A	L
OTHER	41	Relative Machinability (1-10, 1 = Easier to Machine)			1	4	8	1	8

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

(2) Specimens 1/8' thick x 2' dl a. 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
PTM = Polymer Test Method

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

Ertalyte® PET-P	Ertalyte® TX	PC 1000 Polycarbonate	PSU 1000 Polysulfone	Ultem® 1000	Techtron® PPS	Ketron® PEEK 1000	Torlon® 4203	Torlon® 4301	Torlon® 5530	Duratron® XP	Celazole® PBI
Semi-crystalline Thermoplastic Polyester	Semi-crystalline Thermoplastic Polyester	Unfilled Lexan*	Unfilled Polysulfone	Unfilled Polyetherimide	Polyphenylene sulfide	Polyetherether-ketone	Polyamide-imide	Bearing Grade Polyamide-imide	Polyamide-imide	High Purity Polyimide	Polybenzi-midazole
1.41	1.44	1.20	1.24	1.28	1.35	1.31	1.41	1.61	1.45	1.40	1.30
12,400	10,500	10,500	10,200	16,500	13,500	16,000	18,000	15,000	12,000	16,000	20,000
460,000	500,000	320,000	390,000	500,000	500,000	500,000	600,000	900,000	900,000	583,000	850,000
20	5	100	30	80	15	20	10.0	3.0	3.0	4.0	3.0
18,000	14,000	13,000	15,000	20,000	21,000	25,000	24,000	20,000	23,000	20,000	32,000
490,000	360,000	350,000	400,000	500,000	575,000	600,000	600,000	900,000	800,000	600,000	950,000
8,000	8,500	9,200	9,000	15,000	9,000	8,000	16,000	-	16,400	-	-
15,000	15,250	11,500	13,000	22,000	21,500	20,000	24,000	27,000	22,000	24,000	50,000
420,000	400,000	300,000	375,000	480,000	430,000	500,000	478,000	600,000	950,000	450,000	900,000
M93 (R125)	M94	M75 (R126)	M82 (R128)	M112 (R125)	M95 (R125)	M100 (R126)	E80(M120)	E85 (M125)	E70(M106)	M112	E105 (M125)
D87	-	D80	D80	D86	D85	D85	-	D90		-	D94
0.5	0.4	1.5	1.3	0.5	0.6	1.0	2.0	0.7	0.8	1.4	0.5
0.20	0.19	-	-	0.42	0.40	0.40	0.35	0.20	0.20	0.23	0.24
2,800	6,000	-	-	1,875	3,000	8,500	12,500	20,000	22,500	32,500	37,500
60	35	-	-	2,900	2,400	375	50	-	10	50	60
$3.30x10^{-5}$	$4.5x10^{-5}$	$3.90x10^{-5}$	$3.10x10^{-5}$	$3.10x10^{-5}$	$2.80x10^{-5}$	$2.60x10^{-5}$	$1.70x10^{-5}$	2.60×10^{-5}	$1.40x10^{-5}$	2.7×10^{-5}	1.30×10^{-5}
240	180	290	340	400	250	320	532	520	534	680	800 (DMA)
N/A	N/A	293	374	419	N/A	N/A	527	527	527	613	750 (DMA)
491	491	N/A	N/A	N/A	540	644	N/A	N/A	N/A	N/A	N/A
210	210	250	300	340	425	480	500	500	500	580	600
2.0	1.9	1.3	1.8	0.85	2.00	1.75	1.80	2.50	3.70	1.53	2.80
385	-	400	425	830	540	480	580	700	-	700	550
$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{16}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$
-	-	3.17	3.14	3.15	3.0	3.30	4.2	6.3	6.0	3.41	3.2
-	-	0.0009	0.0008	0.0013	0.0013	0.003	0.026	0.050	0.037	0.0038	0.003
H B	H B	V-2	H B	V-O	V-0	V-O	V-0	V-0	V-0	V-0	V-0
0.07	0.06	0.2	0.3	0.25	0.01	0.10	0.4	0.30	0.4	0.4	0.40
0.9	0.47	0.4	0.6	1.25	0.03	0.50	1.7	1.5	1.5	1.3	5.0
A	A	A	A	A	A	A	A	A	A	A	L
L	L	U	U	U	L	L	L	L	L	L	U
A	A	A	A	A	A	A	L	L	L	L	L
U	U	U	U	U	A	A	U	U	U	-	U
A	A	U	U	U	-	A	A	A	A	A	A
A	A	L	L	L	-	A	A	A	A	A	A
A	A	U	U	U	-	A	A	A	A	A	A
A	A	U	L	A	A	A	A	A	A	A	A
U	U	U	U	U	A	A	A	A	A	-	A
A	A	A	A	A	A	A	A	A	A	A	A
A	A	A	A	A	A	A	A	A	A	A	A
L	L	L	L	A	L	L	L	L	A	L	L
2	2	3	3	3	3	5	5	8	5	8	10

TYPICAL APPLICATIONS FOR QEPP'S MOST POPLULAR SEMICONDUCTOR MATERIALS

		Semitron® ESd 225	Semitron® ESd 410C	Semitron® ESd 420	Semitron® ESd 500	Semitron® ESd 520HR	Torlon® 5530 PAI	Duratron® XP	Celazole® PBI	Torlon® 4203 PAI	Torlon® 4301 PAI	UTEM® 1000	Techtron® PPS	Ketron® PEEK	PC 1000	PSU 1000	Ertalyte® PET-P
HANDLING	Wafer Combs	✦	✦	✦				✦	✦	✦		✦					
	Vacuum Wand Tips	✦						✦	✦	✦			✦	✦			
	Flat Finders	✦											✦	✦			
	Screws & Caps							✦	✦								
	Vacuum Wand Handles	✦	✦	✦									✦	✦			
CMP	Retaining Rings (CMP)												✦				✦
	Water Tracks																✦
PLASMA ETCH	Windows														✦		
	Clamp Rings							✦	✦			✦			✦	✦	
	Focus Rings							✦	✦								
BACK END TEST	I. C. Handling Trays		✦	✦													
	Boat Inserts		✦	✦	✦												
	Thermal Isolators				✦						✦						
	Wear Guides									✦							
	Contactors, Nests & Sockets			✦		✦	✦		✦	✦		✦					
	Articulating Plungers										✦						
	Seal Adapters				✦					✦							

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