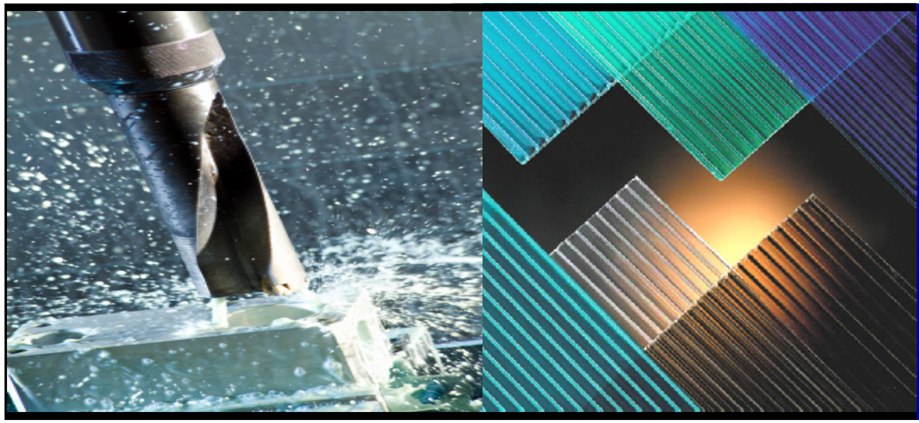
QUADRANT
ENGINEERING PLASTIC PRODUCTS

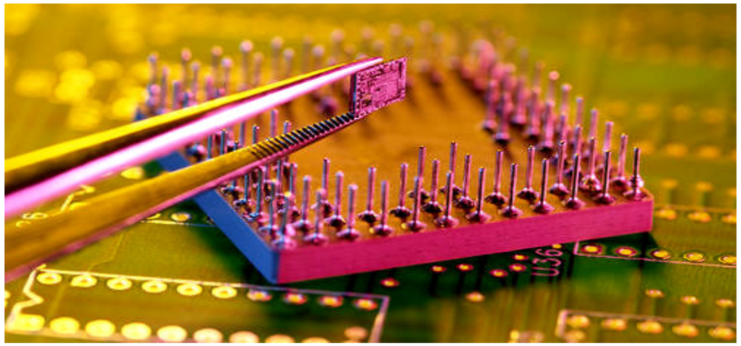
Quadrant Engineering Plastics Products

Semiconductor Solutions

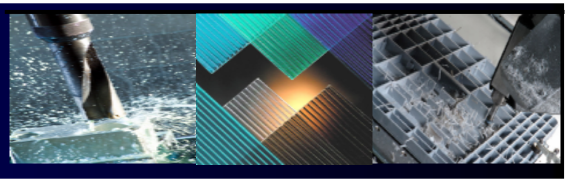


You inspire… we materialize ®

Back End Test



The Changing Environment…

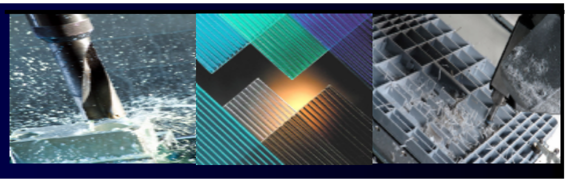


- **Driven by market requirements, the BiTS industry is pushing material science to the brink of polymeric capability**
  - **higher I/O count**
  - **reduction in pitch**

- **The traditional remedy for increasing the stiffness & stability of a polymer works against the requirements for a more machine-able polymer**
  - **to increase stiffness you add fillers to the material**
  - **filled material means decreased machine-ability**
  - **especially in increasing hole & decreasing pitch sizes**

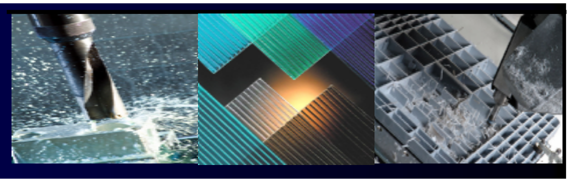
How do we evaluate & compare materials for test applications

Miniaturization of Test Sockets



Year	Pitch	Thru Hole	Wall Size	I/O Count	Materials
1980- 98	2.54mm-1.27mm	1mm - .75mm	.75mm	200	Ultem PEEK
1998-02	1mm-.6mm	.4mm -.65mm	.2mm-.35mm	200-1000	Ultem PEEK Torlon Polyimide
2002-09	.6mm-.4mm	.3mm - .4mm	.1mm-.2mm	Up to 2500	PEEK Torlon Polyimide
2009-12	.4mm-.25mm	.2mm - .3mm	.05mm-.01mm	??????	??????

Methodology to Compare Materials

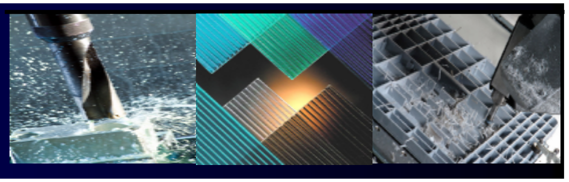


Statement: Since we are focused on the increasing I/O count and reduction in pitch size we conclude that the **machine-ability** of the polymer & the stability of the polymer are key components to achieving next generation socket designs

Broad Definitions

- **Machine-ability** – the ability to successfully machine a given hole pattern
- **Polymeric Stability** – The ability of the polymer to maintain shape during the machining process and throughout the useful life of the socket

Polymeric Stability

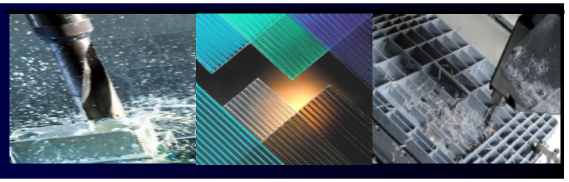


- Polymeric stability in Test Socket applications relates specifically to the polymer substrates ability to withstand minimal dimensional change during the machining phase and testing phase

- The polymers ability to withstand dimensional change is characterized by two factors:
  - *Stiffness of the polymer*
  - *Expansion of the polymer over useful temperature range*

- Two accepted methods for measuring stiffness & expansion
  - *Flexural Modulus @ 73°F (D790) – a measure of the ability of the polymer to withstand bending under a given load*
  - *CLTE (-40°F - 400°F, E-831) – measure of the dimensional change over a wide temperature range*

Measuring Polymeric Stability



Formula:

$$\frac{\text{Flexural Modulus @ 73°F} \qquad 10\cancel{0}{,}000}{\text{CLTE @ (-40°F to 300°F)} \qquad 1\cancel{0}^{\,-5}}$$

- Higher numerator / higher stiffness - desired
- Lower denominator / less expansion - desired
- thus… higher overall polymeric stability factor desired

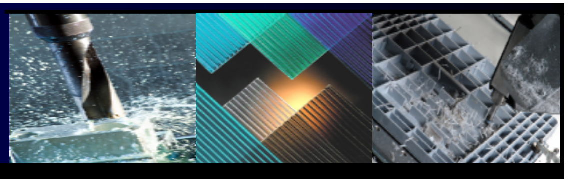
Formula applied to Semitron® MDS-100

Sample Calculation:

$$\frac{1{,}420{,}000 \qquad 10\cancel{0}{,}000}{1.1\ \text{X}\ 10^{-5} \qquad 1\ \cancel{\text{X}}\ 10^{-5}} = \boxed{12.91}$$

12.91
Polymeric Stability Factor

Comparison of Materials

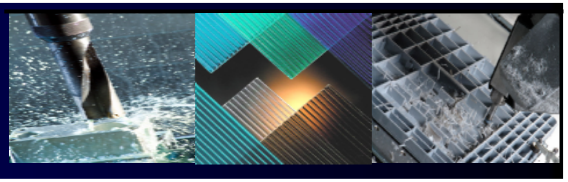


Comparison of Common Test Polymers for Stability using the Formula

Resin	CLTE (E-831) (-40 - 300F) X10-5	Flex Modulus D-790	Polymeric Stability Factor
Polyimide	3.05	450,000	1.48
PEEK	2.60	500,000	1.92
Ultem 1000 (PEI)	2.60	600,000	2.31
Ceramic Filled PEEK	2.00	650,000	3.25
30% GF PAI	2.60	900,000	3.46
Unfilled PAI	1.70	600,000	3.53
MDS-100	1.10	1,420,000	12.91

Polymeric Stability Factor: higher value = more stable

Machine-ability

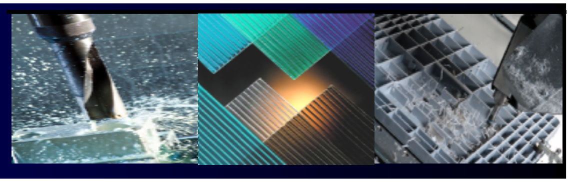


For the purpose of Back End Test applications, machine-ability is defined as the polymers capacity to successfully machine decreasing cross-sections defined by decreasing wall thickness between holes *(larger holes, decreasing pitch, higher I/O count)* and decreasing overall part thickness

Factors Affecting Machine-ability

- **Heat sensitivity at point of drill contact**
- **Ability of the polymer to resist movement & remain rigid during machining - *ductility***
- **The homogeneous nature of the polymer**

Measuring Machine-ability

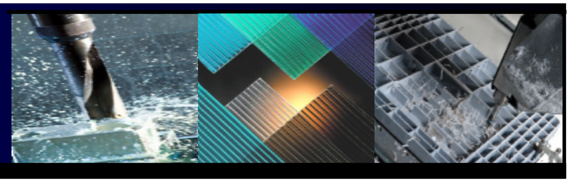


- **Tg or Glass Transition (D3148) – the temperature at which a material softens**
  - ***Higher temp resistance means cleaner holes***

- **Tensile Elongation (D638) – a measure of the elastomeric properties of a material. For machining fine features, increased rigidity is desired**

- **Fillers – fillers used to increase the physical properties of the polymer have an adverse affect on the machine-ability of small features**
  - ***Fibers have greater negative impact***
  - ***Particulate have less impact on performance***

Measuring Machine-ability



Formula: Tg *(°F)* -- Tensile Elongation (%) = Machine Ability Factor

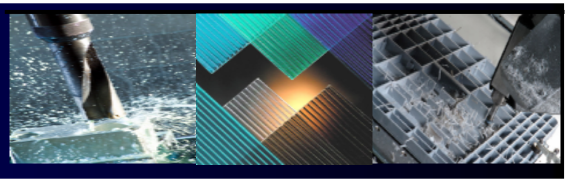
Apply Filler Factor: Machine Ability Factor X 0.25 for fiber fillers / 0.85 for particulate fillers

Formula applied to Torlon® 5530 PAI (30% GF)

Sample Calculation: (527° - 3) (.25) = 131 / 100

1.31
Machine Ability Factor

Comparison of Materials

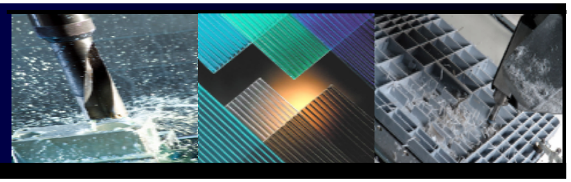


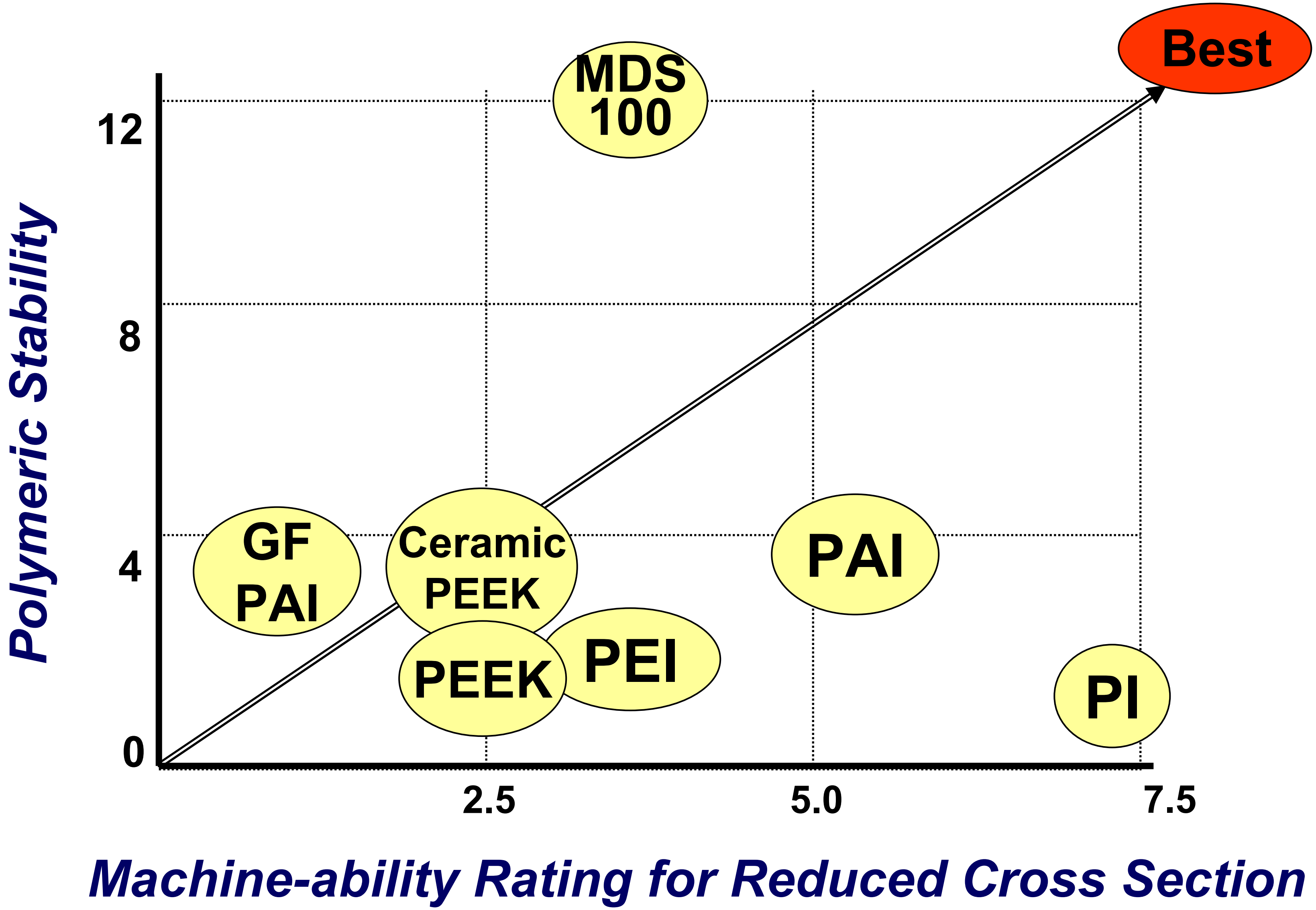
Comparison of Common Test Polymers for Machine-ability using the Formula

Polymer	Tg	Tensile Elogation	Filler Factor	Machine-ability Factor
Polyimide	752	7.5	O	7.4
Torlon 4203 (PAI)	527	10	O	5.2
Semitron MDS-100	350	1.5	O	3.5
Ultem 1000 (PEI)	410	80	O	3.3
GP PEEK	290	40	O	2.5
Ceramic PEEK	290	10	(0.90)	2.5
Torlon 5530 PAI (30%GF)	527	3	(0.25)	1.3

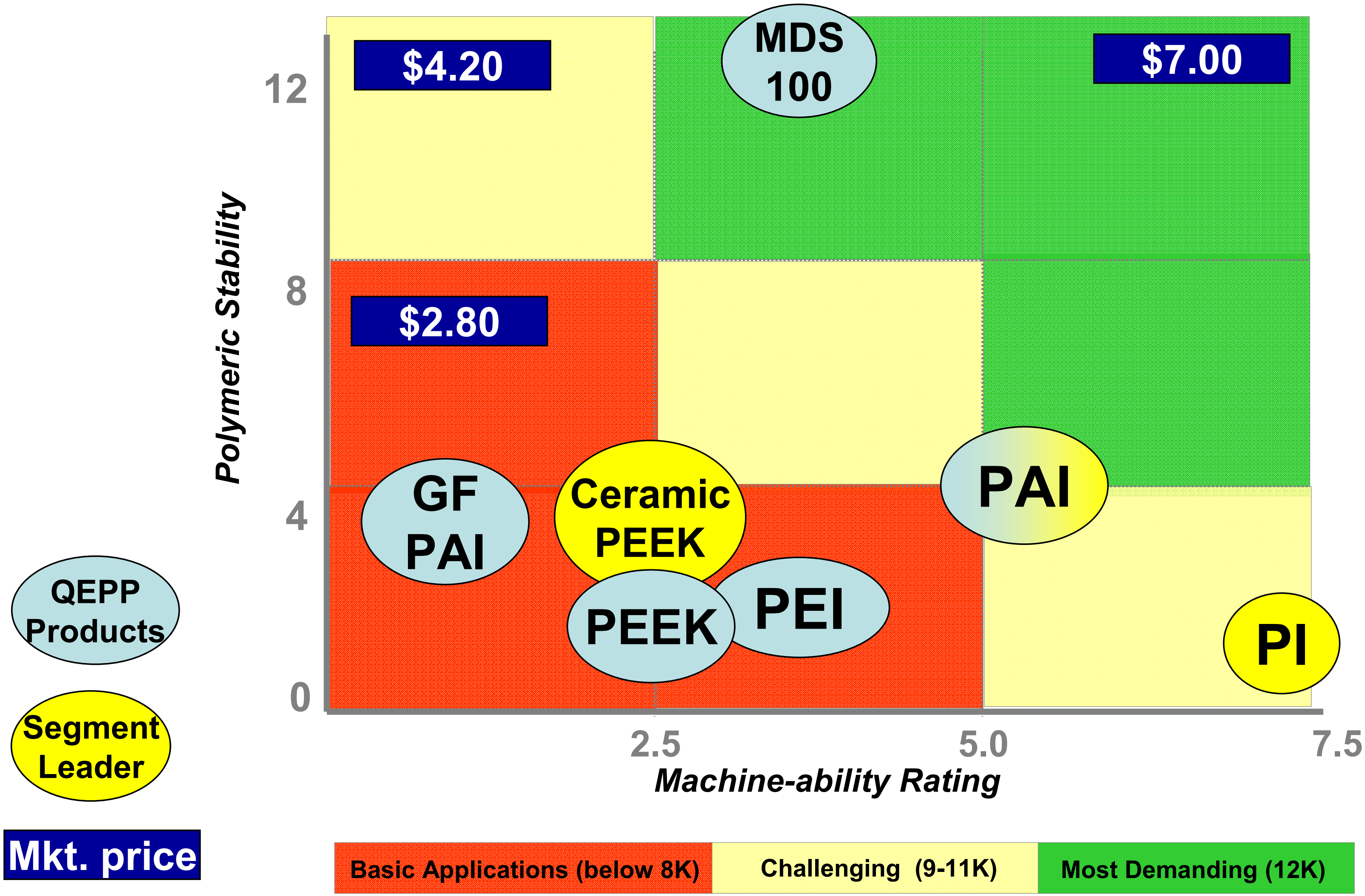
Polymer Machine-ability Factor: higher value = ease of machining

Comparison of Materials

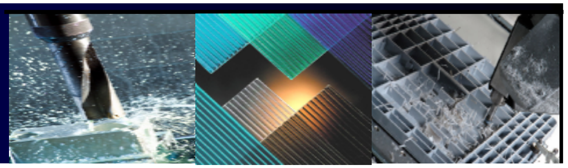




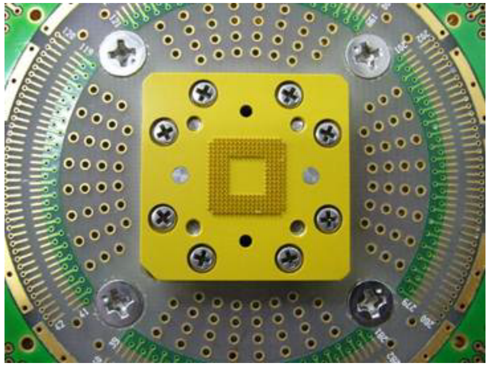
Portfolio Discussion – GAP Analysis



Test Sockets 2009 – 2012 and beyond

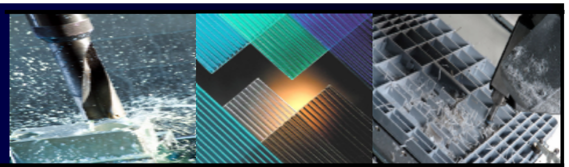


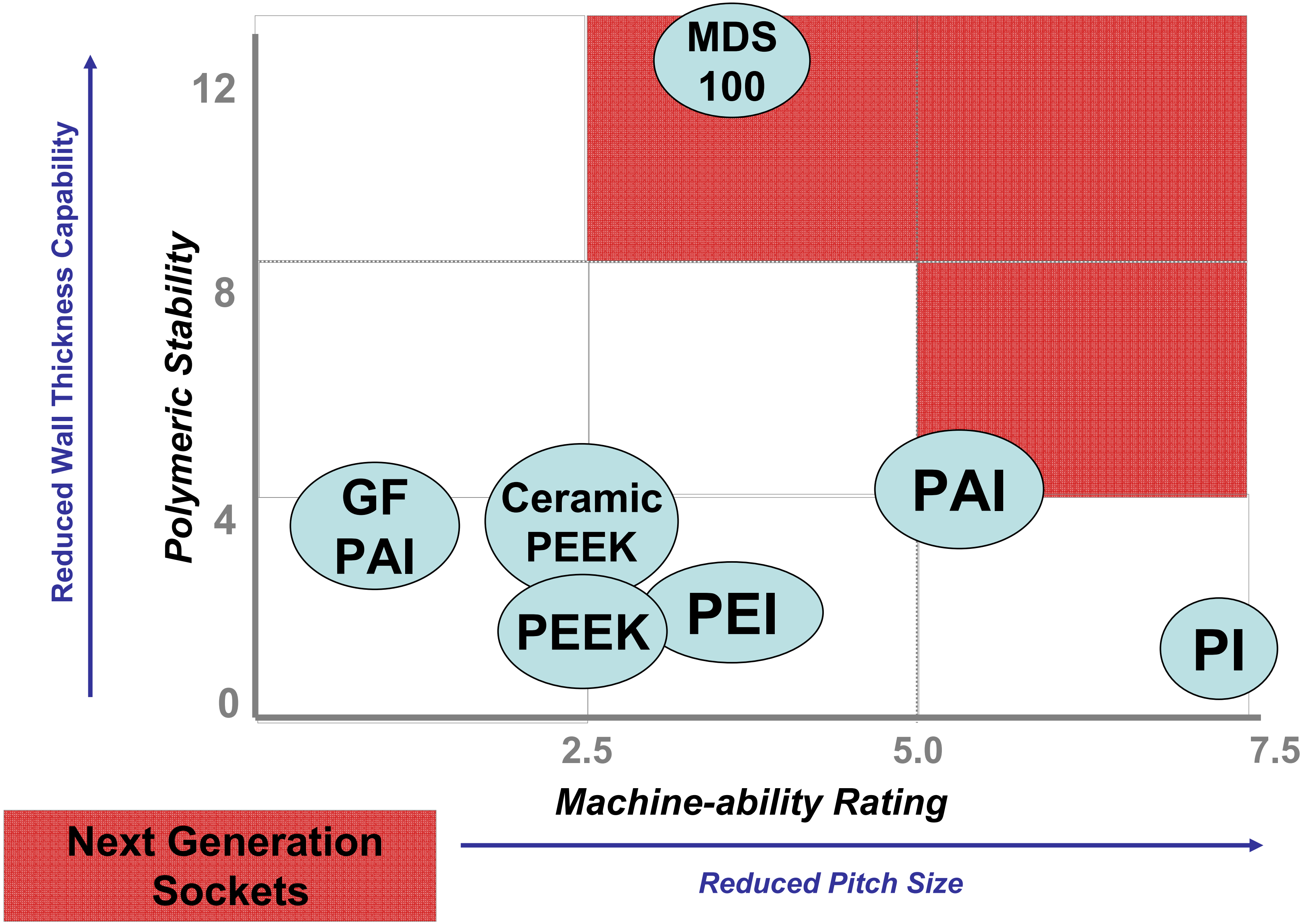
Reduced Cross Section Sockets



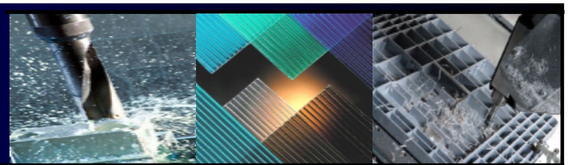
Pitch	0.4mm – 0.25mm…
Thru Hole	0.2 mm – 0.3mm
Wall Size	0.05mm – 0.1mm
I / O count	+++
Materials	???

If you use the grid to select…





Summary ~ Next Generation Sockets



- **Over the next few years, Industry changes will push traditional materials beyond their performance limits.**

- **Increased I/O counts. Smaller I/O pitches, thinner cross sections, increased loads per sq/in, smaller diameter holes, are issues we see today and will be at the forefront of issues leading into the next decade**

- **Using the Polymeric Stability along with the Machine-ability index will guide Engineers to right material from the start**

- **Semitron® MDS 100 will allow Engineers to work around design limitations associated with traditional materials.**

	Pitch	Thru Hole	Wall Size	I/O Count	Materials
2009 - 2012	.4mm-.25mm	.2mm - .3mm	.05mm-.01mm	?????	Semitron® MDS 100