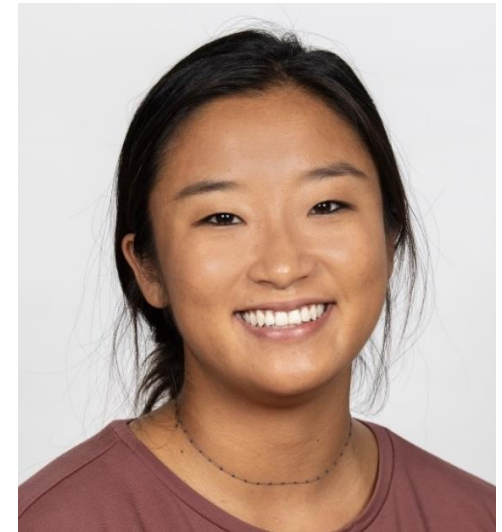


- Development Engineer at Kayaku Advanced Materials, Inc.
- Located in Westborough, MA, USA
- Formerly MicroChem Corporation
- Specialty chemicals for MEMS, microelectronics, and semiconductor device packaging



Katie Han

# Novel Low Temperature Curable Photo-Patternable Low Dk/Df for Wafer Level Packaging (WLP)

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- Wafer Level Packaging
- Polymer Design Strategy & Photolithography
- Characteristic Properties & Reliability
- Conclusions

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## Mega Trends



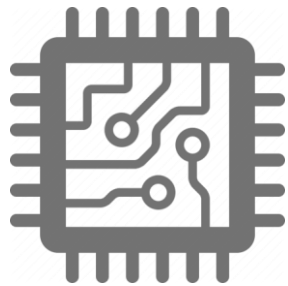
- Higher Bandwidth
- Lower Power Consumption
- High Functionality
- More Memory & Sensors
- Lower Latency
- Further Miniaturization



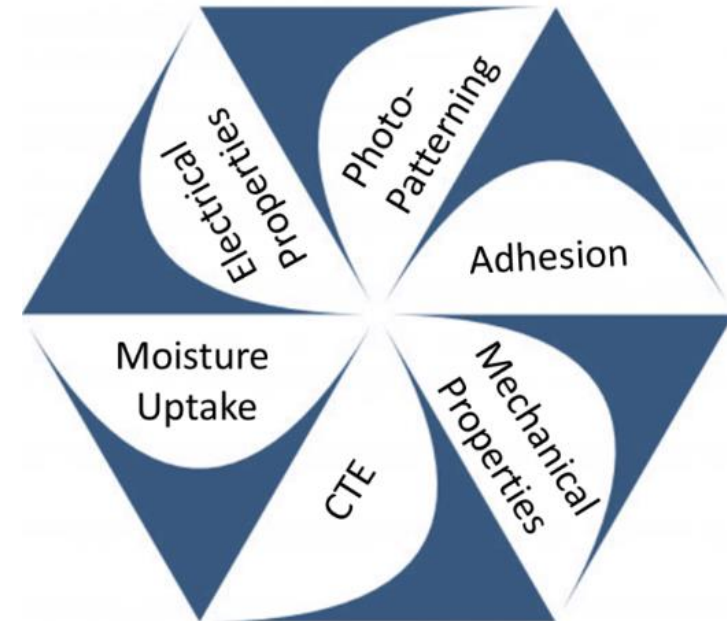
Stability with increasing frequency and temperature



Cost

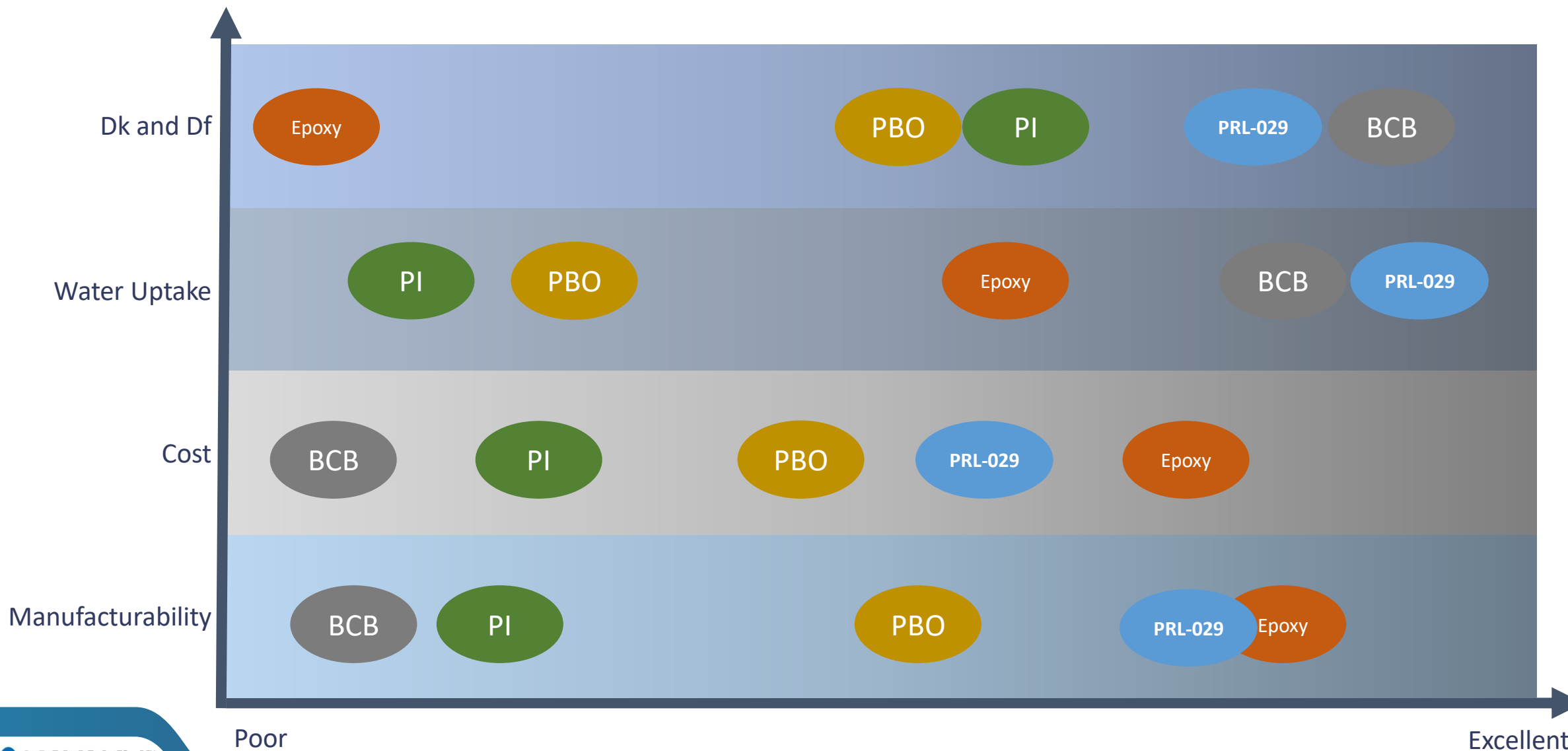


Manufacturability



“Hexagon of Death”

# Polymeric Dielectric Materials

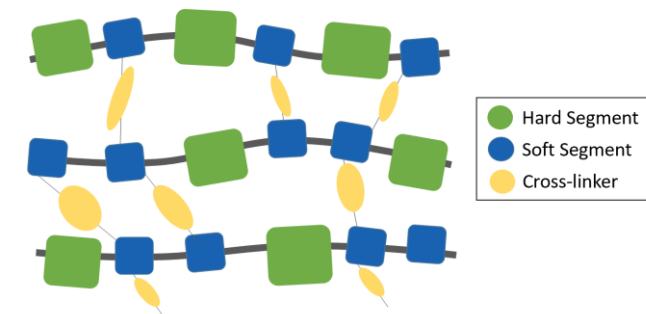
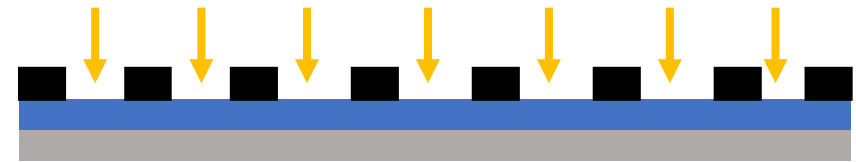


- Introduction
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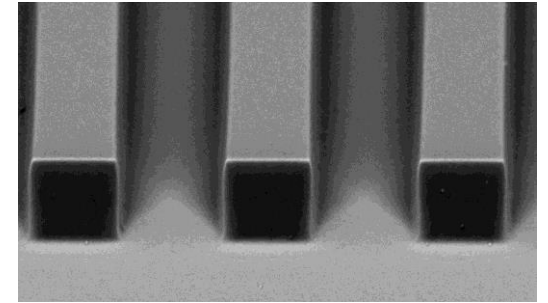
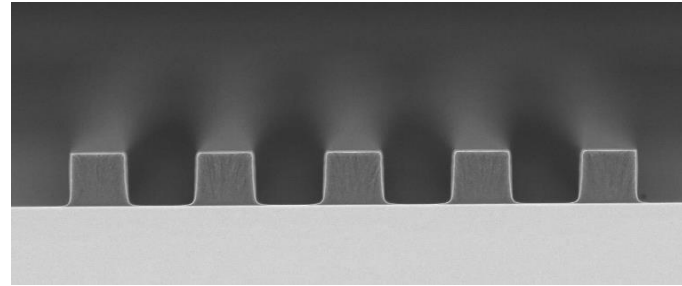
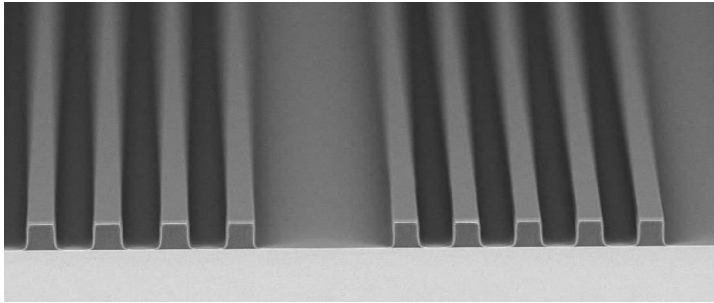




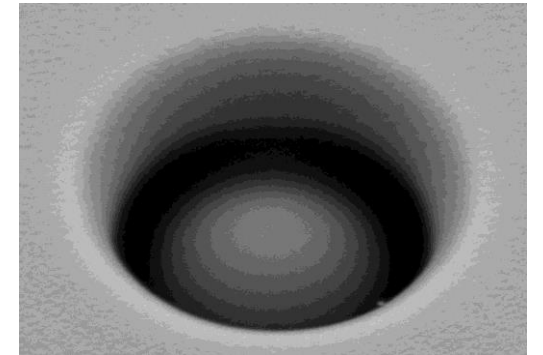
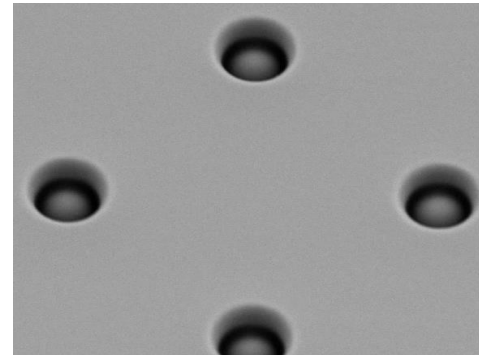
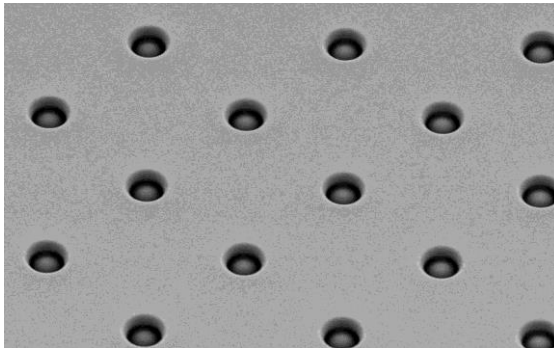
1. Spin-coat between 1000-2000 RPM
2. Soft bake 95°C/2mins
3. Broadband Exposure 50-200mJ / cm<sup>2</sup>
4. Post Exposure Bake 95°C – 125°C / 2 mins
5. Solvent Develop in PGMEA
6. Hard Cure 200°C for 1 hour in N<sub>2</sub>



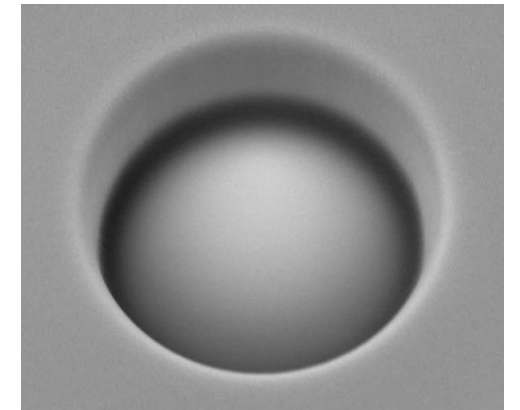
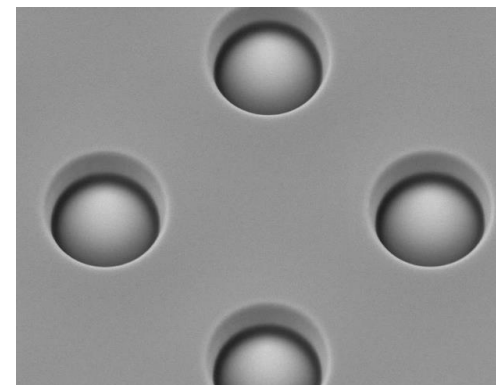
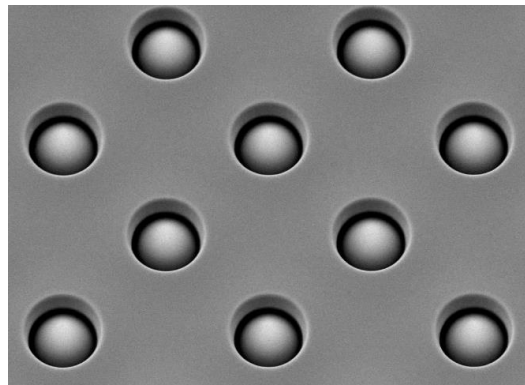
15um L&S



15um Vias



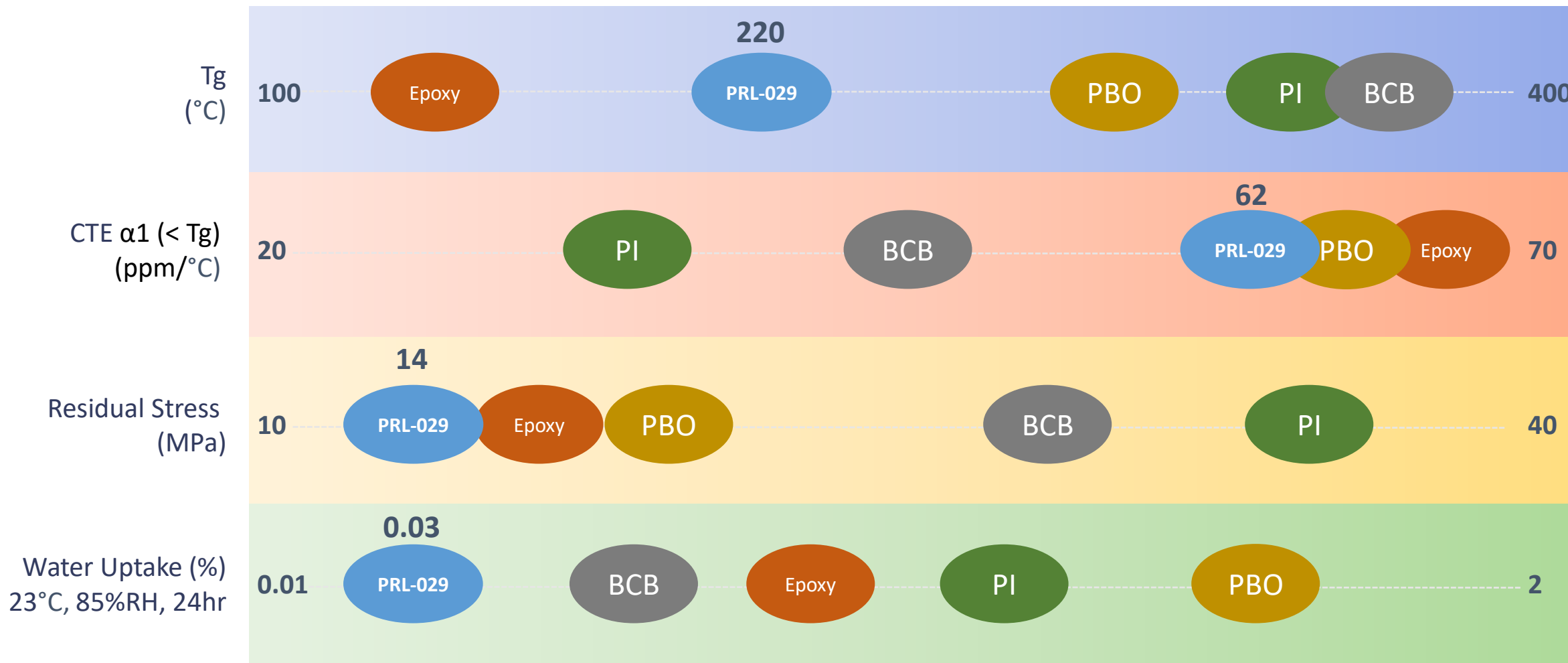
20um Vias



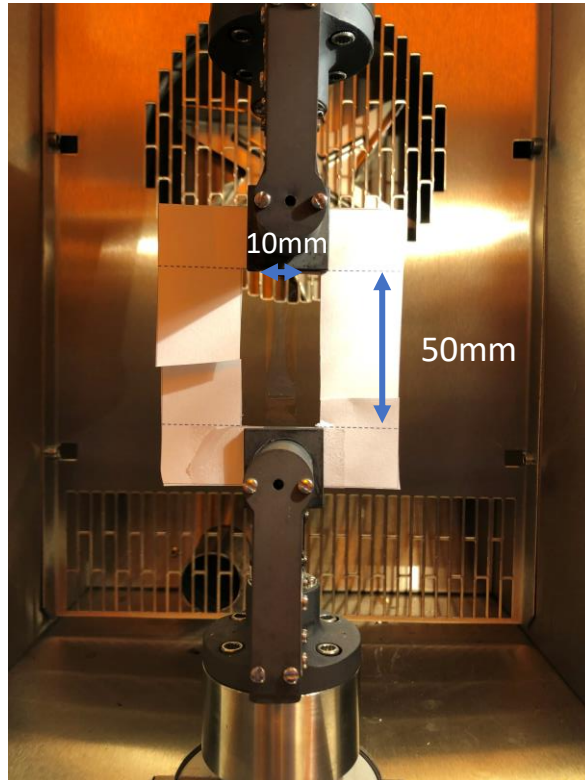
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- Physical
- Mechanical
- Dielectric

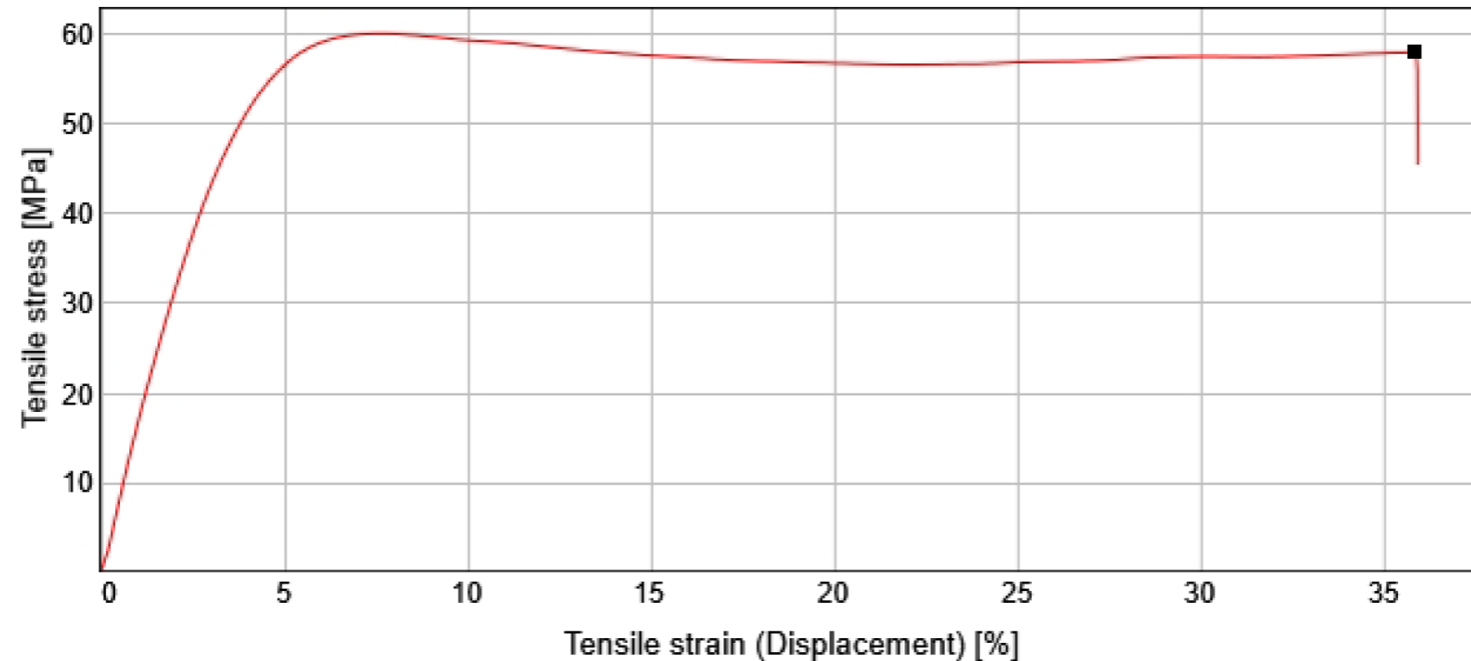
# Physical Properties



~15 $\mu$ m film thickness, Pull-rate 50mm/min



PRL-29 Elongation and Tensile Strength

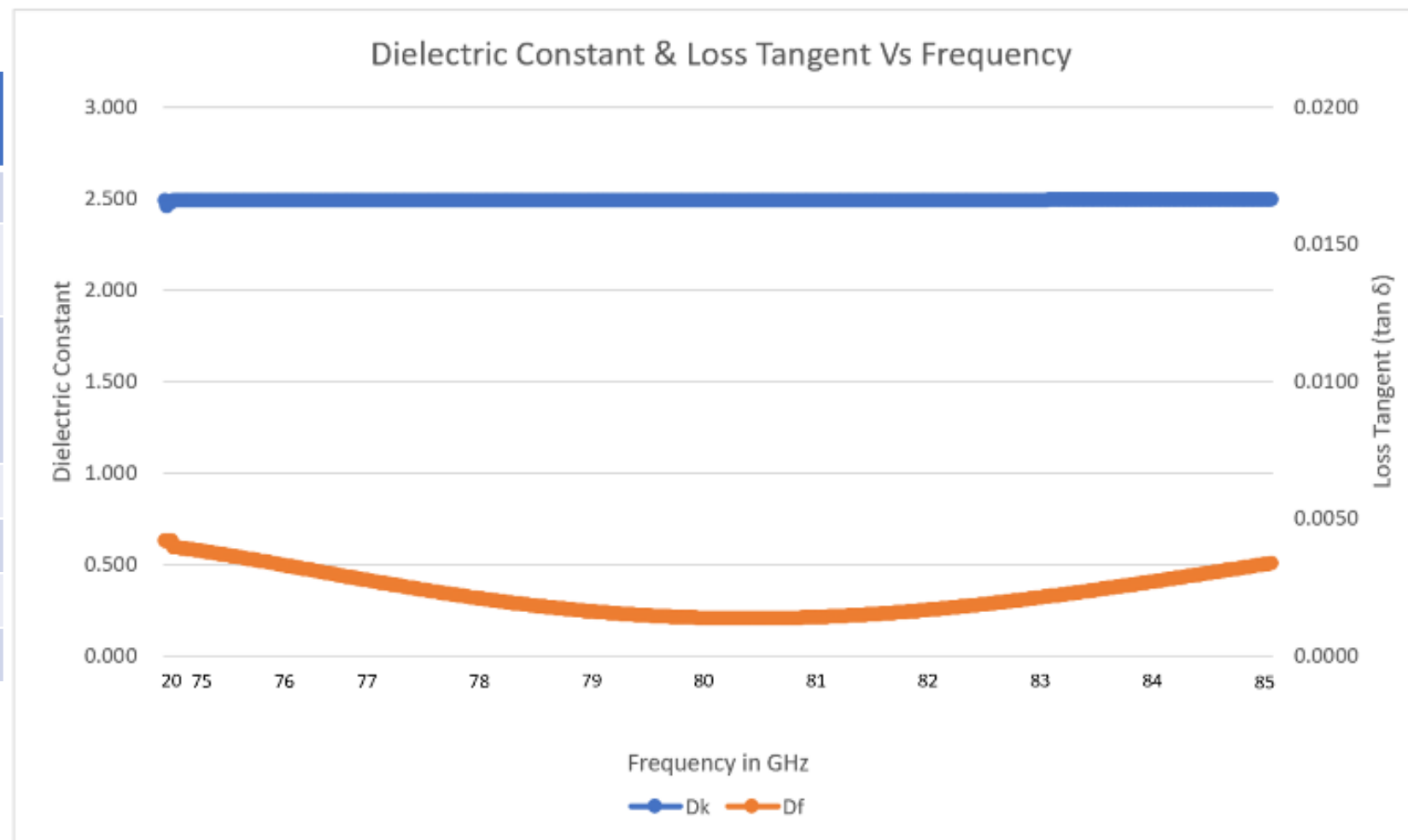


Mechanical Properties	Unit	Value
Young's Modulus	GPa	1.8
Tensile Strength	MPa	60
Elongation at Break (MAX) 10mm x 50mm, 50mm/min	%	35



# Dielectric Performance up to 85GHz

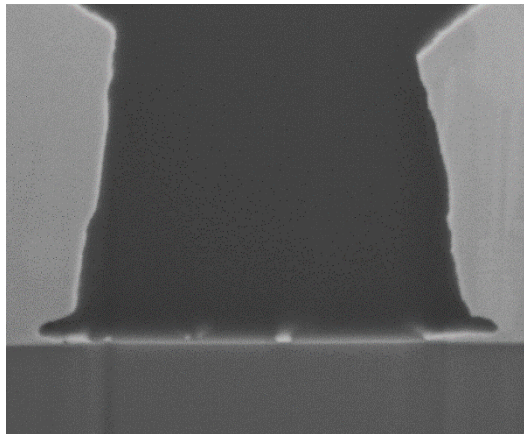
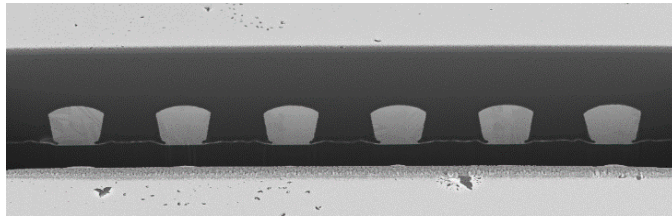
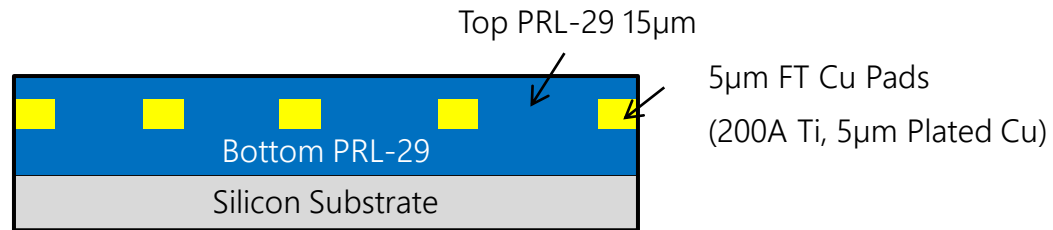
Frequency	Film Length x Width x Thickness	Dielectric Constant (Dk)	Dissipation Factor (Df)
1 GHz	3mm x	2.63	0.005
10 GHz	80mm x 100um	2.54	0.004
20 GHz	40mm x 40mm x 50um	2.48	0.004
70 GHz	4mm x 4mm x 1.5mm	2.49	0.004
75 GHz		2.48	0.004
80 GHz		2.48	0.001
85 GHz		2.49	0.003





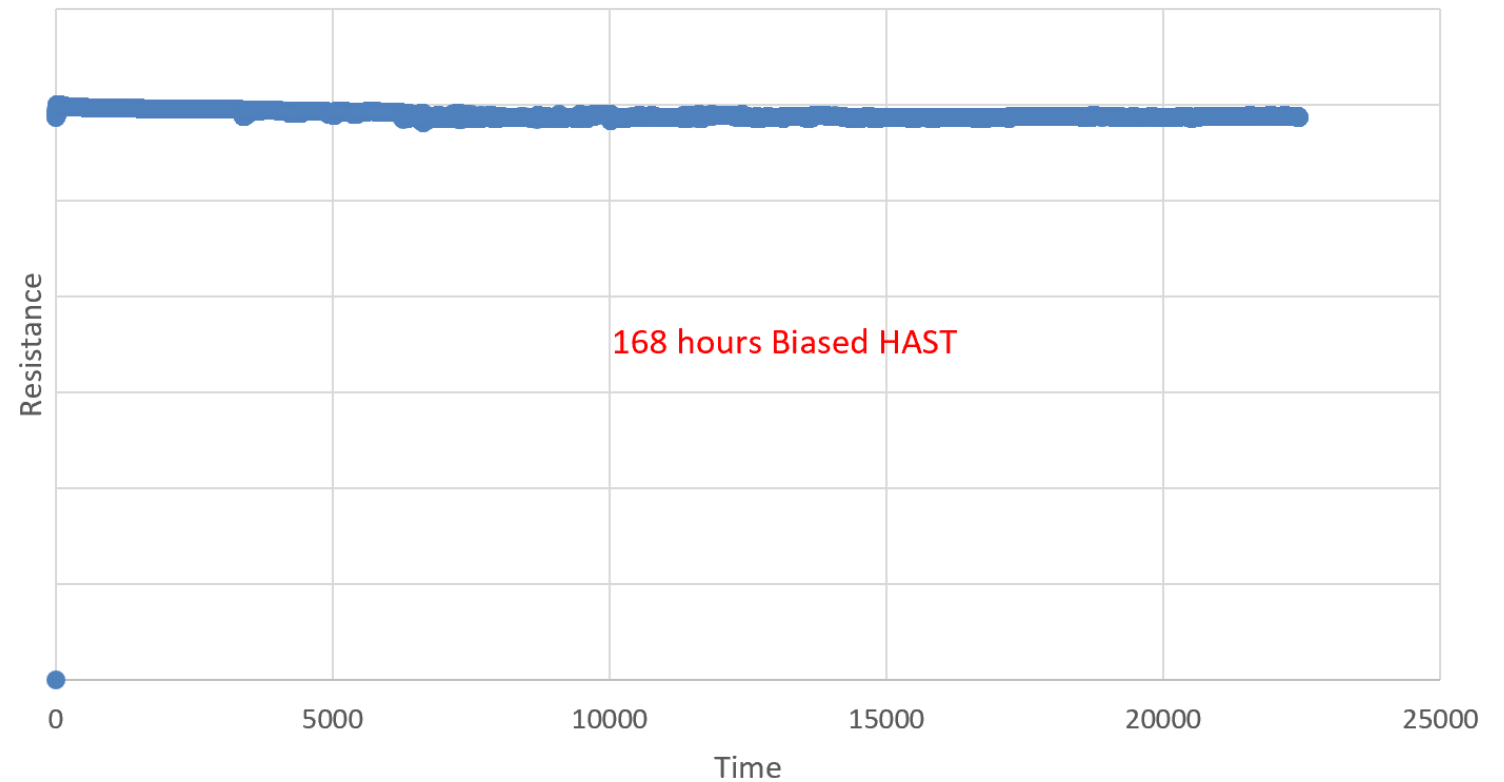
- Bias HAST
- Modulus Temperature Stability
- Pressure Cooker Test Adhesion
- High Temperature Test
- Chemical Resistance

# Bias HAST: 85°C, 85% RH, 3.3 Volts, 168 hours

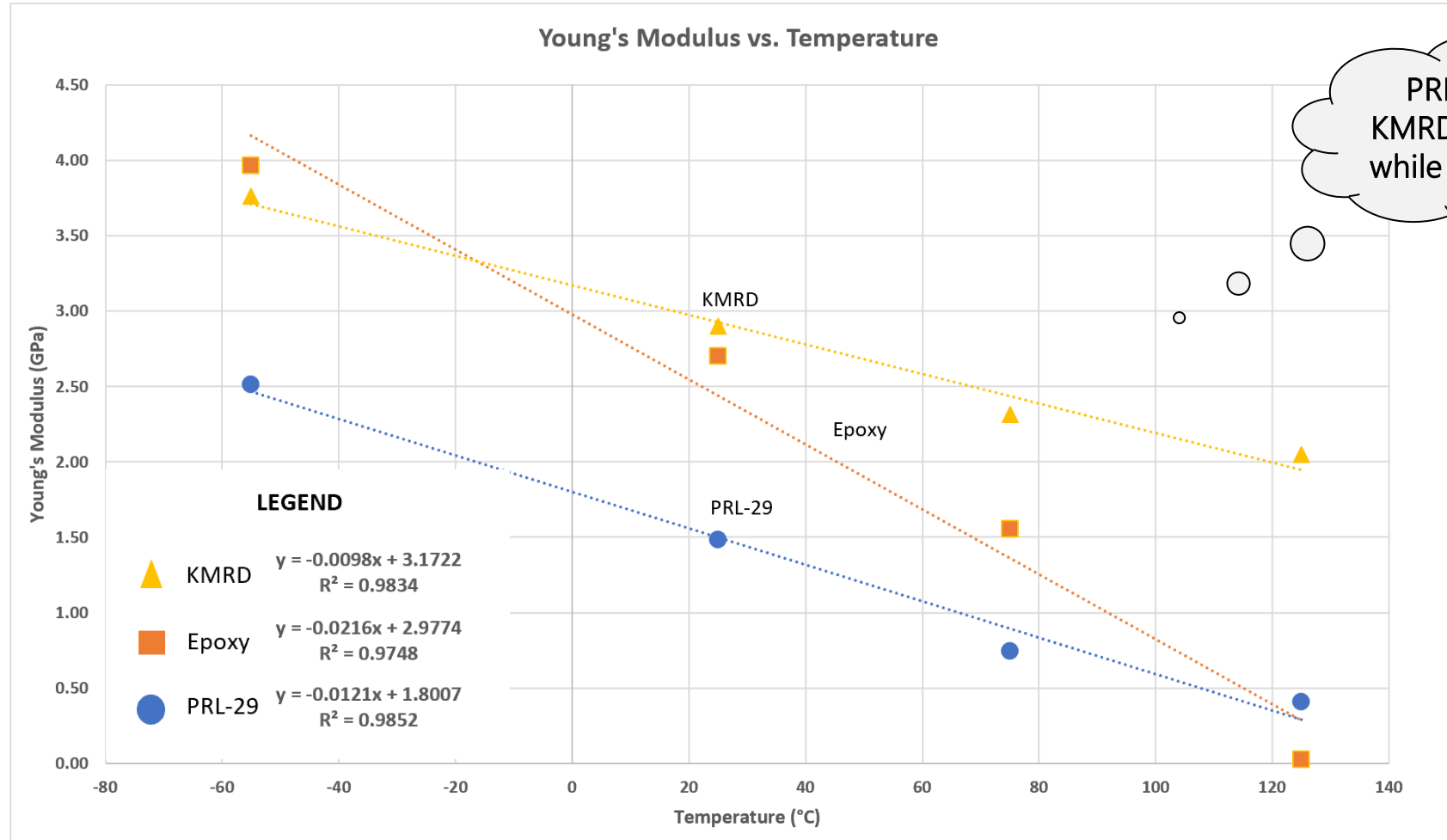


- ✓ No copper migration
- ✓ No delamination

PRL-29 Bias HAST Resistance

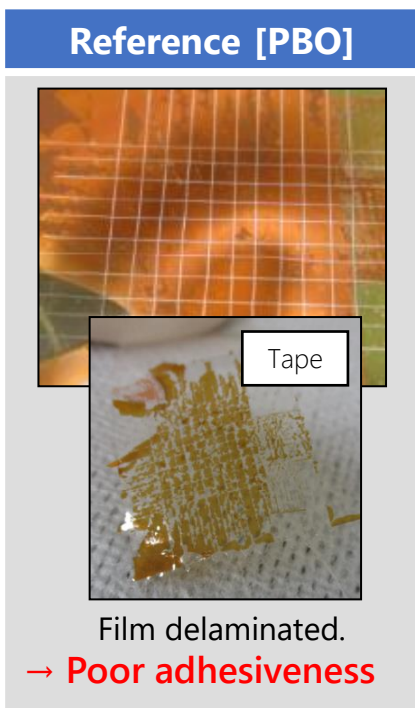


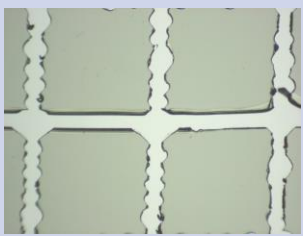
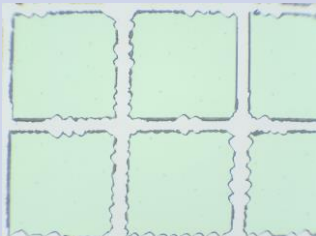
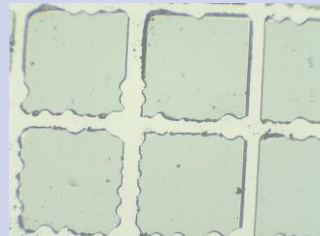
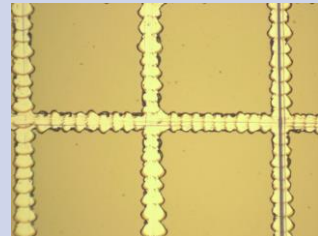

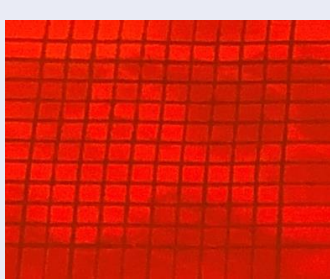


# Stable Young's Modulus from -55°C – 125°C

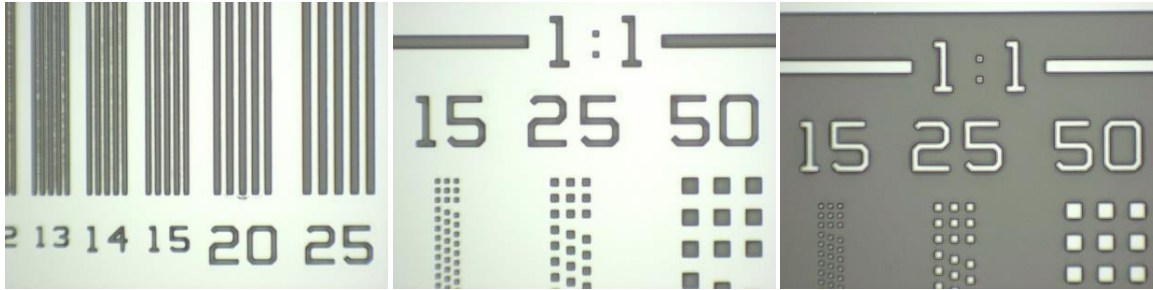


PRL-29 and KMRD are stable while epoxy fails.

# Pressure Cooker Testing (PCT)

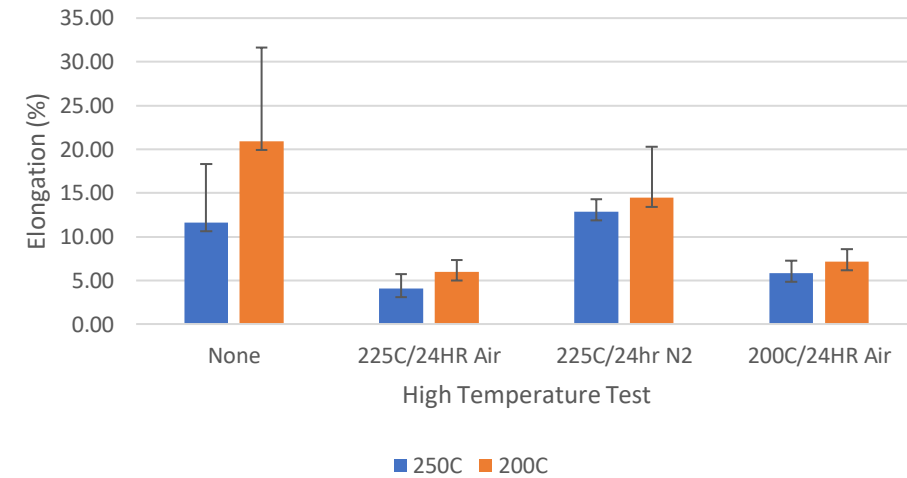


Substrate	Silicon	Silicon Dioxide	Silicon Nitride	Gold	Copper
Shear Adhesion Before PCT (MPa)	35	36	36	40	In Process
Shear Adhesion After PCT (MPa)	33	35	33	29	In Process
Cross-hatch Tape Peel Test After PCT  121C, 100%RH, 2atm, 48hrs				Delamination	
					

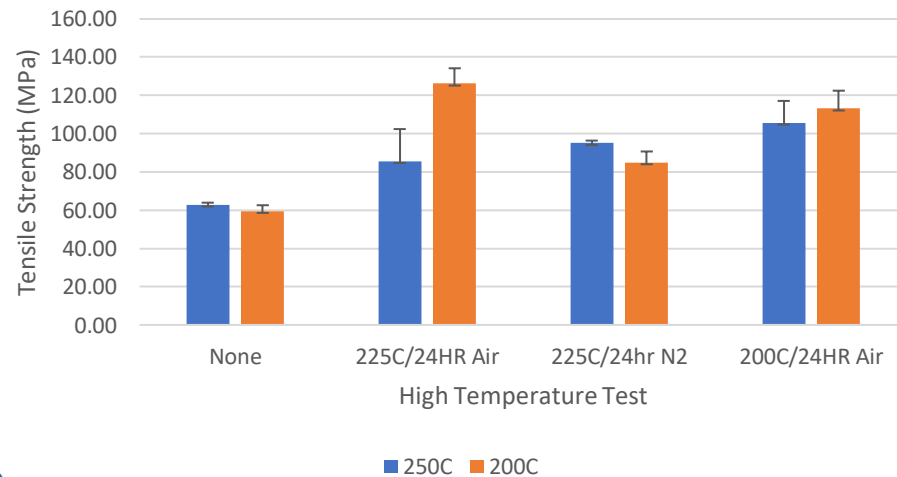


No cracking or delamination after HTT 225°C/24hr under Air

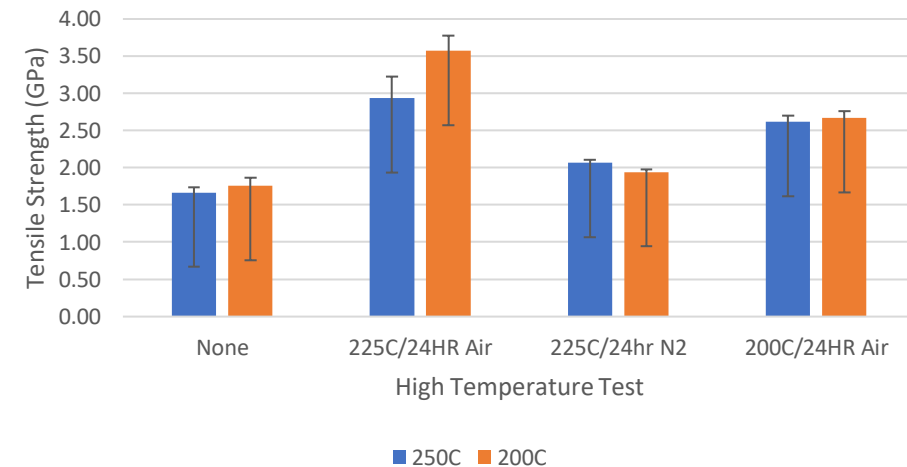
Elongation



Tensile Strength



Young's Modulus



Chemicals	Treatment Condition		Check Item	Appearance – Ok? Film Loss - Y/N
	Temperature (°C)	Time (mins)		
NMP	80	60	Appearance	Ok
			Film Loss	No
DMSO	90	60	Appearance	Ok
			Film Loss	No
Acetone	25	60	Appearance	Ok
			Film Loss	No
10% H <sub>2</sub> SO <sub>4</sub>	25	15	Appearance	Ok
			Film Loss	No
2.38% TMAH	25	15	Appearance	Ok
			Film Loss	No
BOE (6:1 NH <sub>4</sub> F:HF)	25	60	Appearance	Ok
			Film Loss	No

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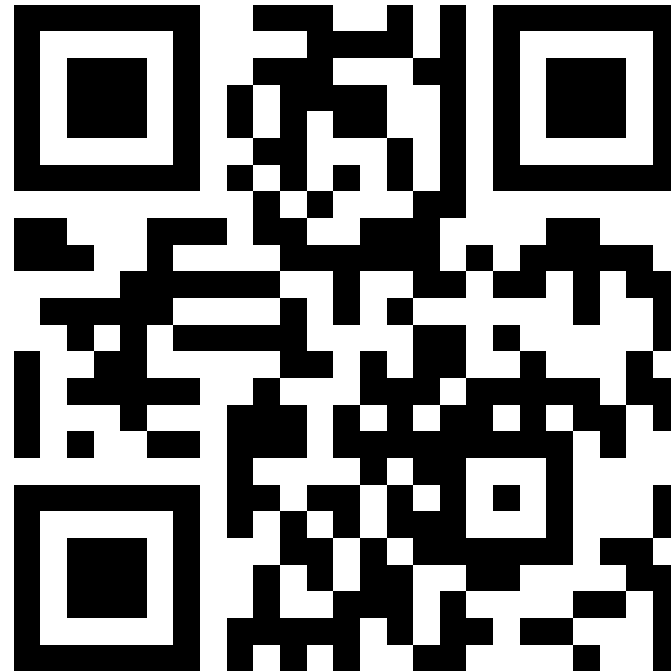


- Photo-Dielectric Layer for Advanced Wafer Level Packaging
- Solvent Developable in PGMEA, Negative Tone
- Single Stage, Low Temperature Cure, 1 hour at 200°C
- Good Chemical and Thermal Stability
- High Reliability
- Low Dk and Df
- 1:1 Aspect Ratio



# Thank you!

For questions and comments please follow the QR code below:



We are actively looking for evaluation partners.

## Stay Safe!