Optimizing Negative-Tone Resist Removal Processes

A New Adhesive for Substrate Thinning and Processing

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Director of Product Development

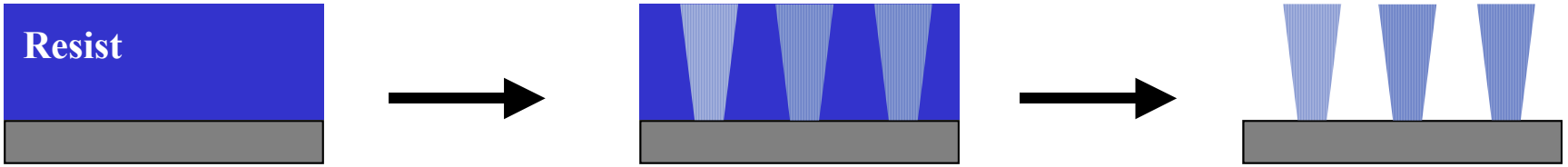
General Chemical Corporation

Negative Resist

Neg Resist Application
Spin-on, Dry Film
Novolak, Acrylic,
Isoprene

Imaging Process
Cross-link Reaction

Chemical Develop
Cross-link Patterns
Remain w/Neg Slope



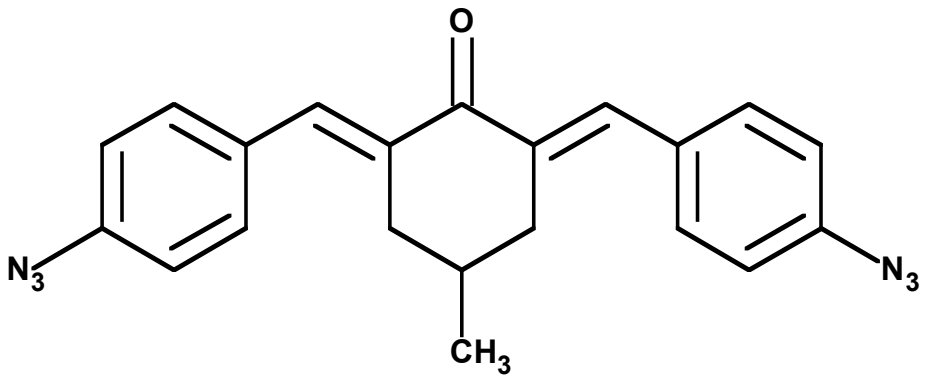
Solvent
Soluble

Exposure -
Curing &
Crosslinking

Unexposed -
Solvent
Soluble

Rubber (Isoprene)

Free-Radical Conversion



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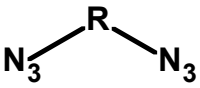
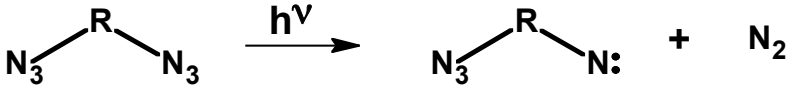
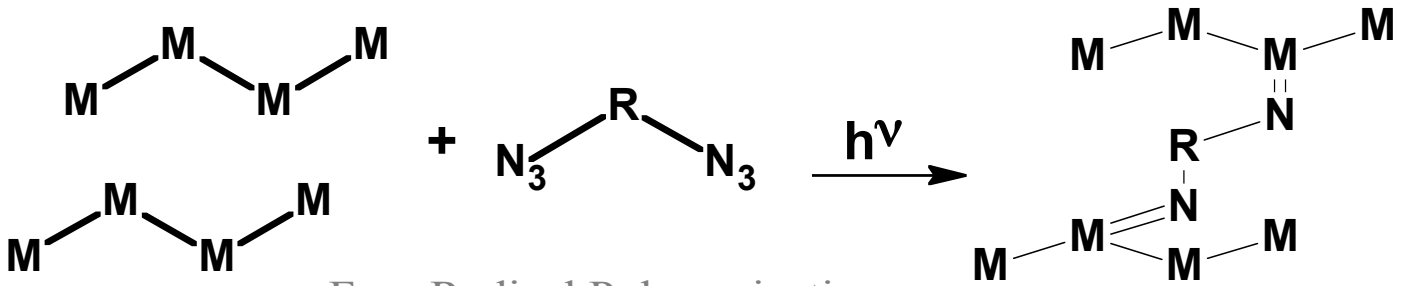


Bis-Aryl Azide



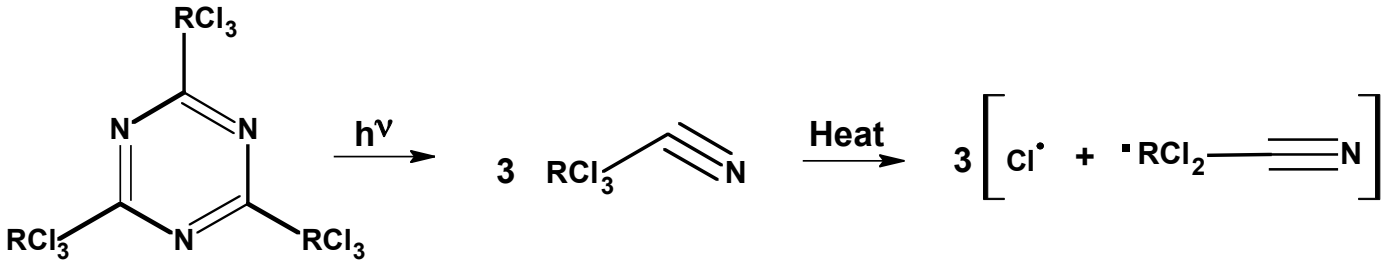


Free-Radical Polymerization

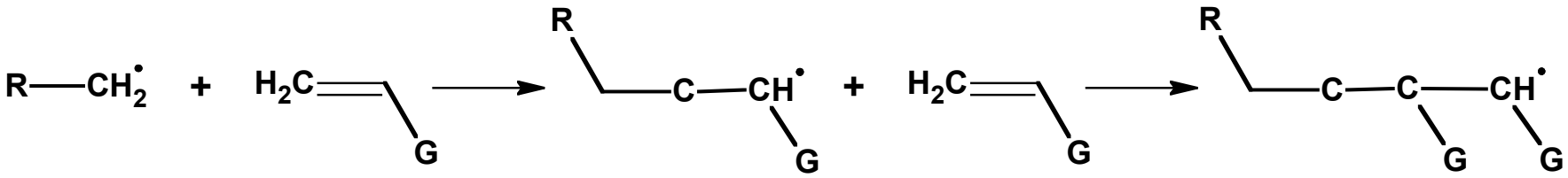
Between Chain Crosslinking

Triazine & Chem Amplified (Novolak)

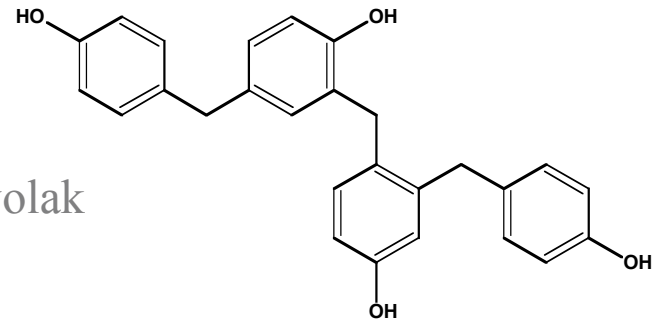
Free-Radical Conversion



Triazine Nitrile Free-Radical



Free-Radical Polymerization

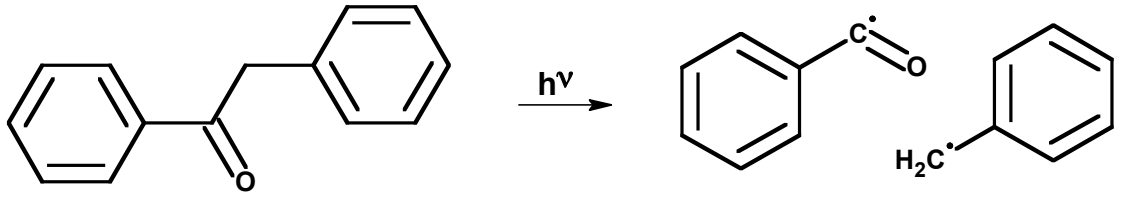


Novolak

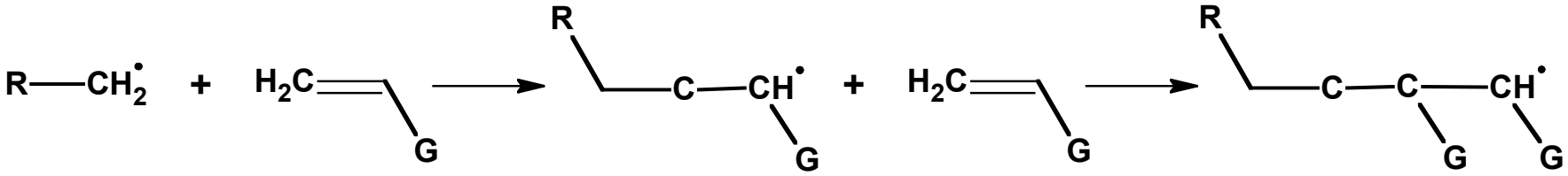
Homopolymer & Copolymer Formation

Dry-Film (Acrylic)

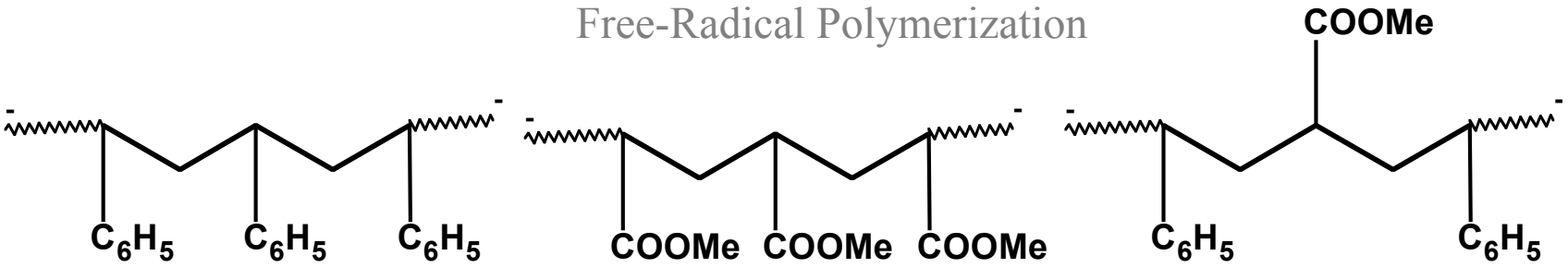
Free-Radical Conversion



2-Phenyacetophenone Benzoyl Benzyl



Free-Radical Polymerization

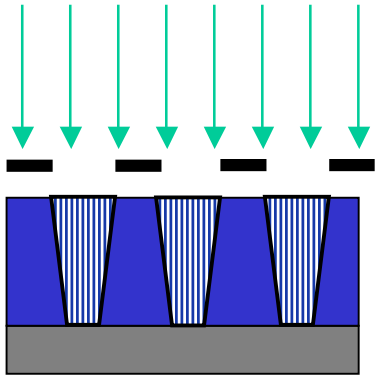


Homopolymer & Copolymer Formation

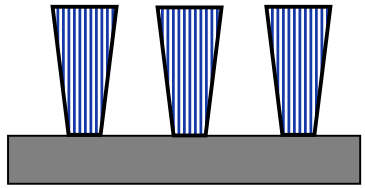
Metal Lift-Off Process
Negative-Tone Resist

Neg Resist Application
Spin-on, Dry Film
Novalak, Acrylic,
Polyolefin

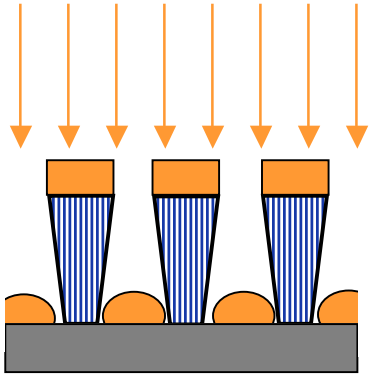
Imaging Process
Cross-link Reaction



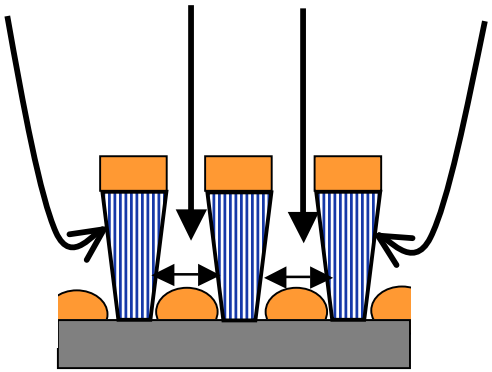
Chemical Develop
Cross-link Patterns
Remain w/Neg Slope



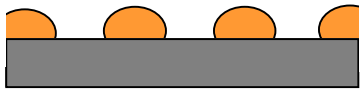
Metal Deposition
Sputtering



Solvent Lift-Off
Side Wall Penetration



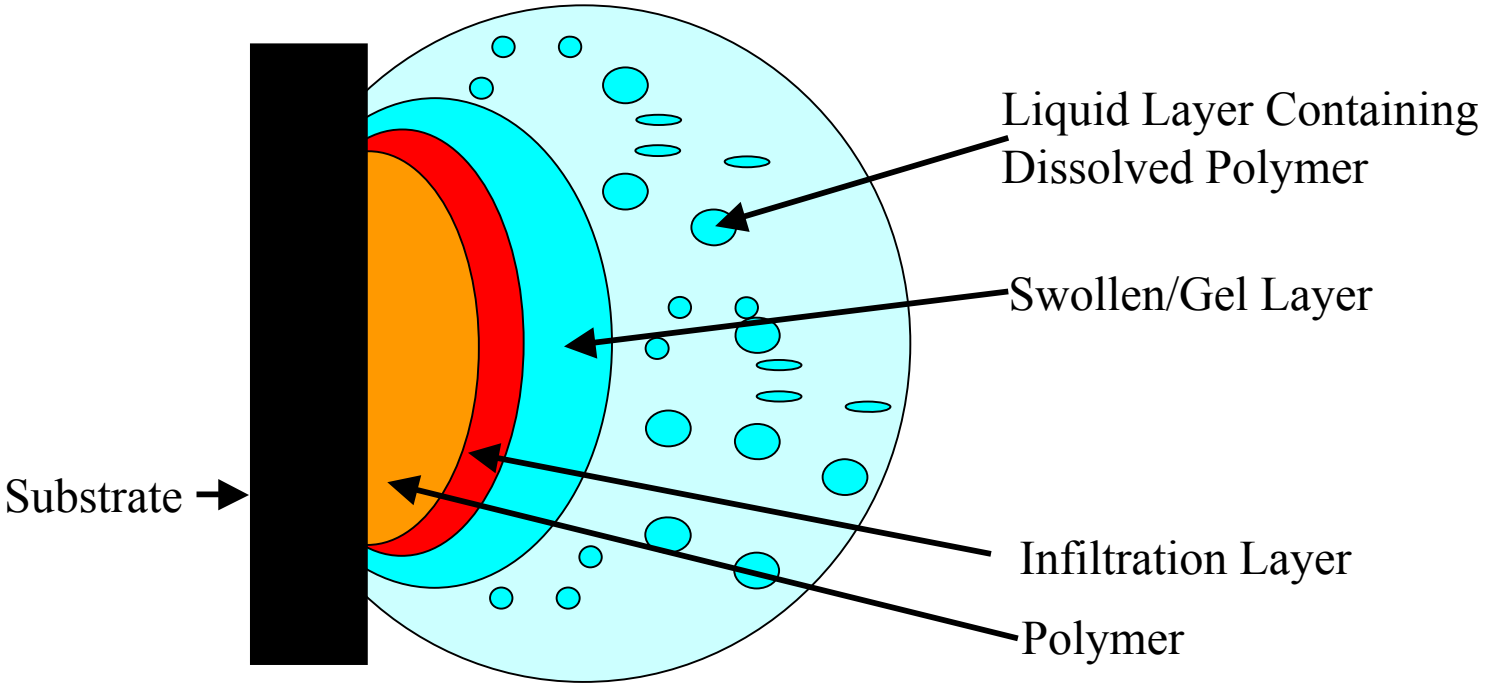
Metal Line
Edge Definition
Au, Cu, Pt, etc.



Acrylic Removal Performance

- Strip systems cured @ 90-110C
- Strip systems exposed under extreme conditions
- Strip systems PEB @ >230C
- Non-TMAH, non-EA amine
- Copper and Al safe
- May be used in spray tool or immersion
- Designed for straight DI rinsing

Polymer Dissolution (Stripping)



- Matching of Chemistry - Key for Infiltration and Holding Capacity in the Liquid Layer
- Polymer Dissolution - Dependent upon Transition to Successive Layers.
- Diffusion Governs Transport Between Layers.
- Temperature, Agitation, and Surface Tension will Enhance Diffusion.

Process Optimization Opportunities

- Increase resist thickness & slope
  - minimize bridging,
  - accelerate stripping
  - isolate metalization
- Reduce temperature & exposure to crosslink chemistries
- Metal protection - no hazing or redeposition

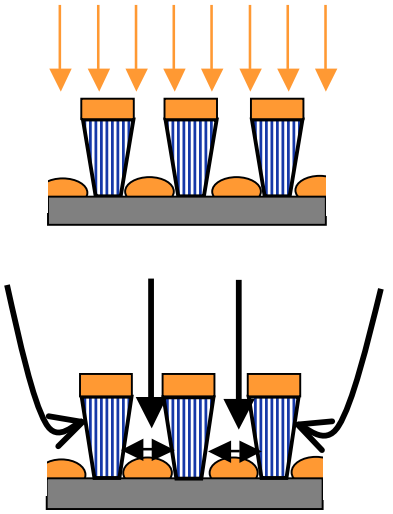
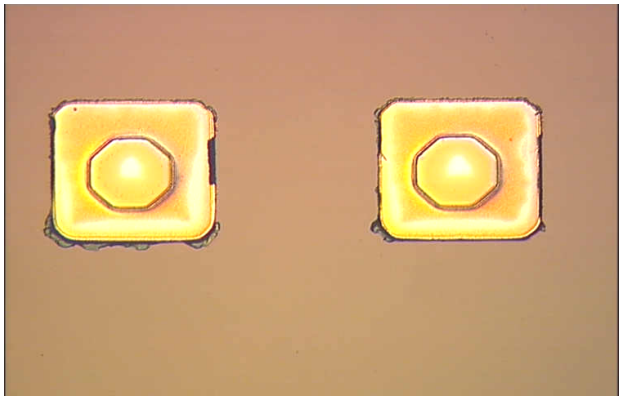
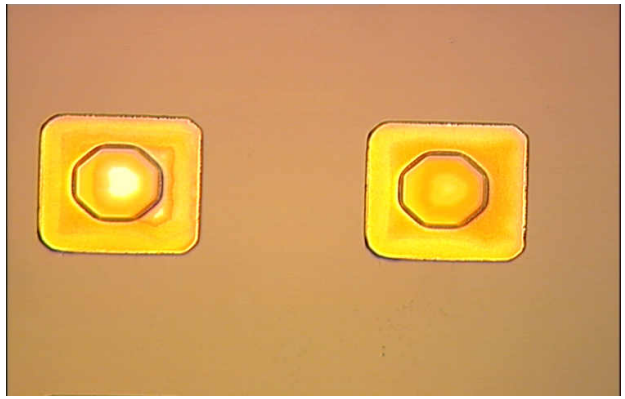


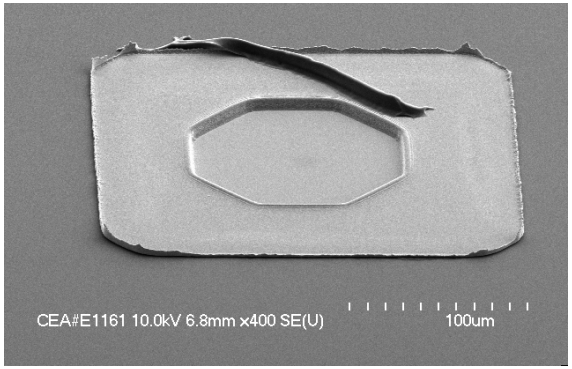
Photo Optimization

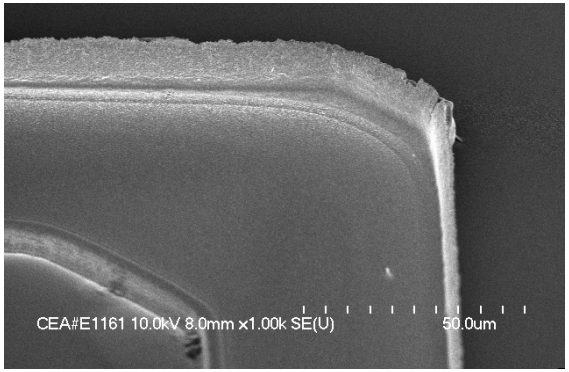
Cu Pad on Si with polyimide field

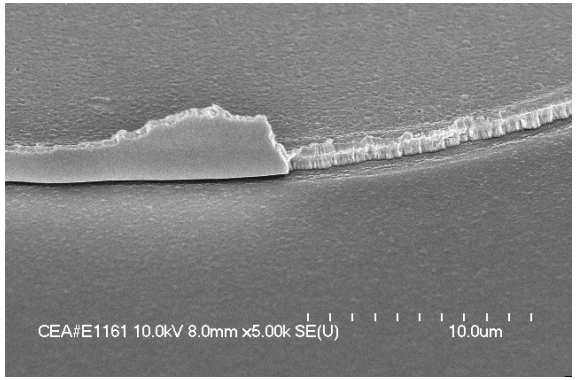


Resist Thickness Change





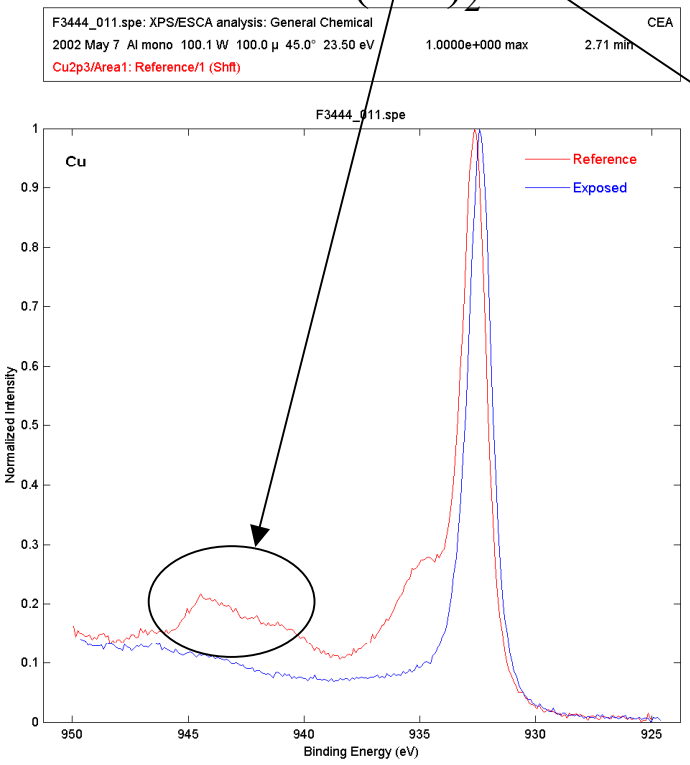


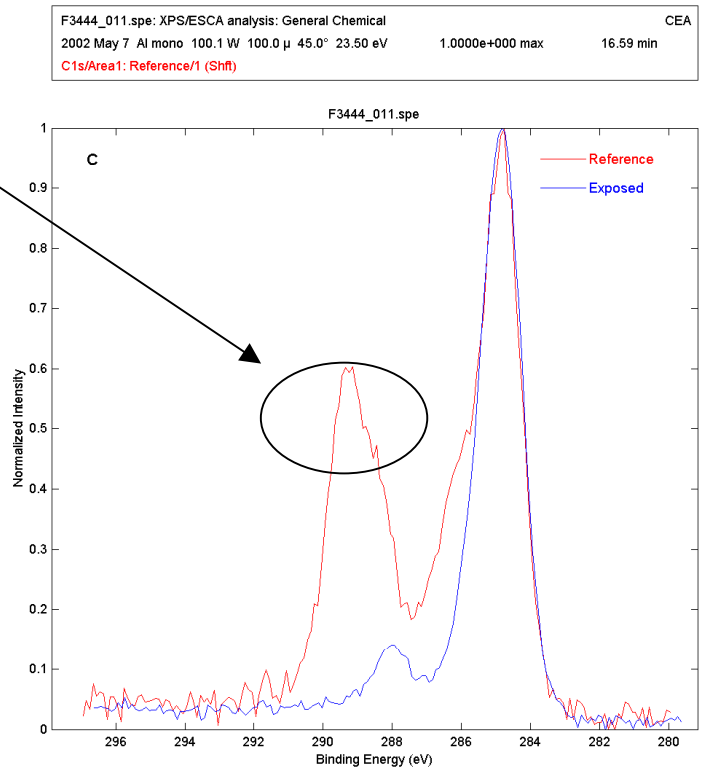


Metal Protection
ESCA/XPS - Cu ECD

Reference -
Adventitious
Cu as CuO and $Cu(OH)_2$

Exposed - protected surface
Cu as Cu_2O and Cu (metal)



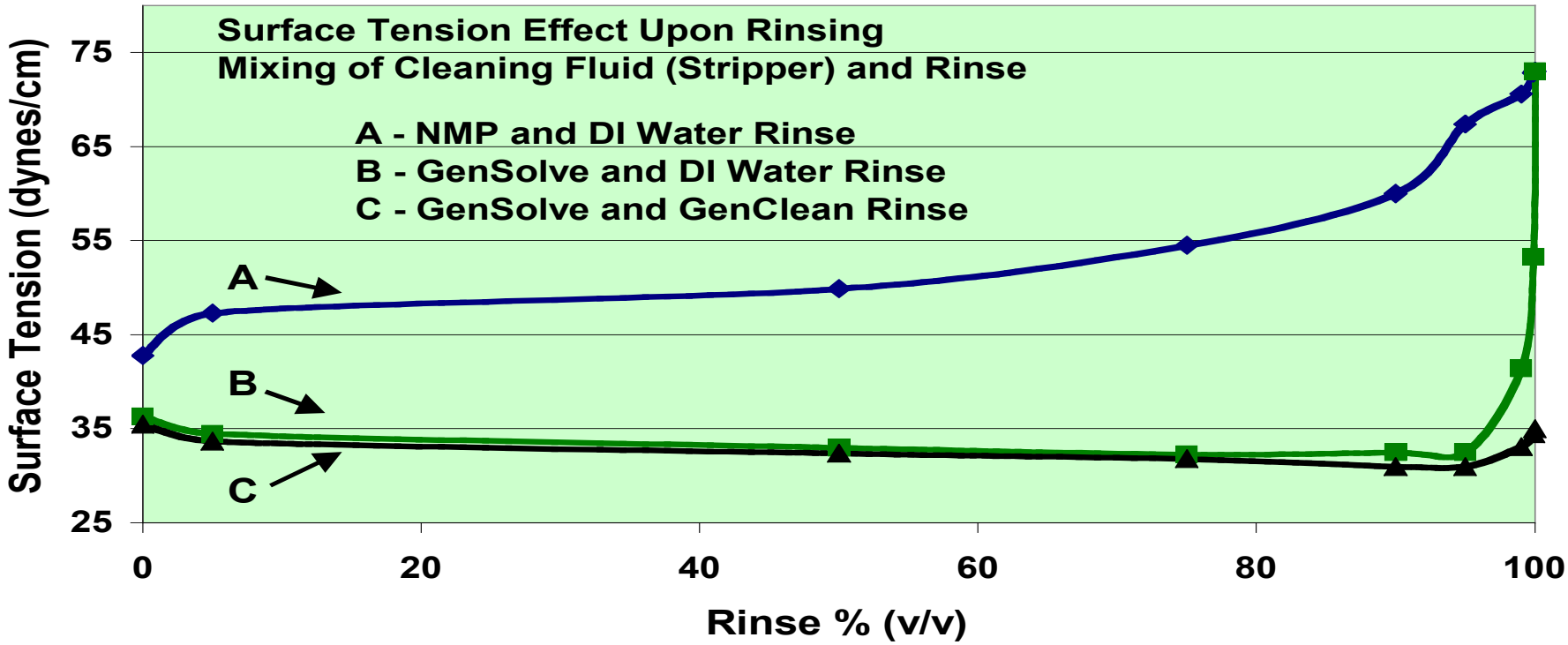


Post-Strip Rinsing Optimizing Results

- Surfactant Package - Reduced Surface Tension
- Maintain Agitation
- Emulsifies (maintains solubility) of Dissolved Species (Polymer)
- Prevent Redeposition
- Acts as a Rinse Aid for DI Water

GenClean™ Rinse Model

Surface Tension vs Mixing

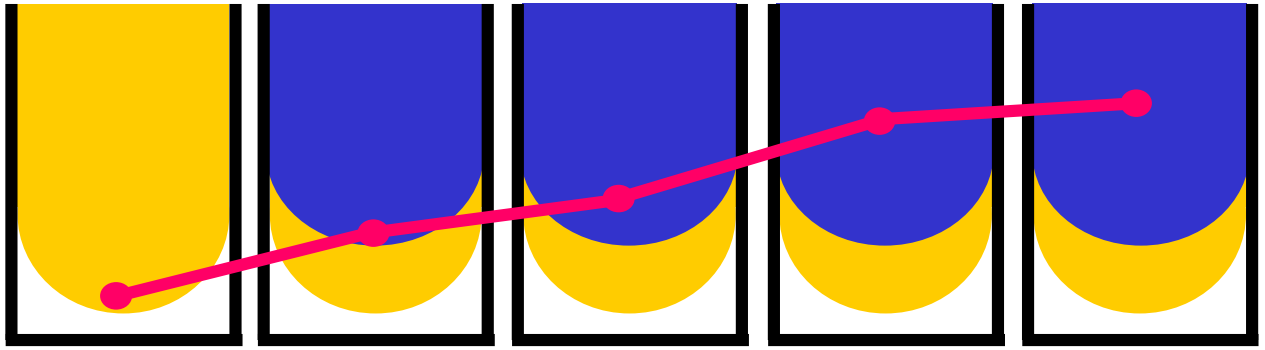


GenClean™ Rinse Model

Surface Tension vs Mixing

Solvent (NMP) Rinsed with DI Water

%Rinse =	0	50	75	95	100

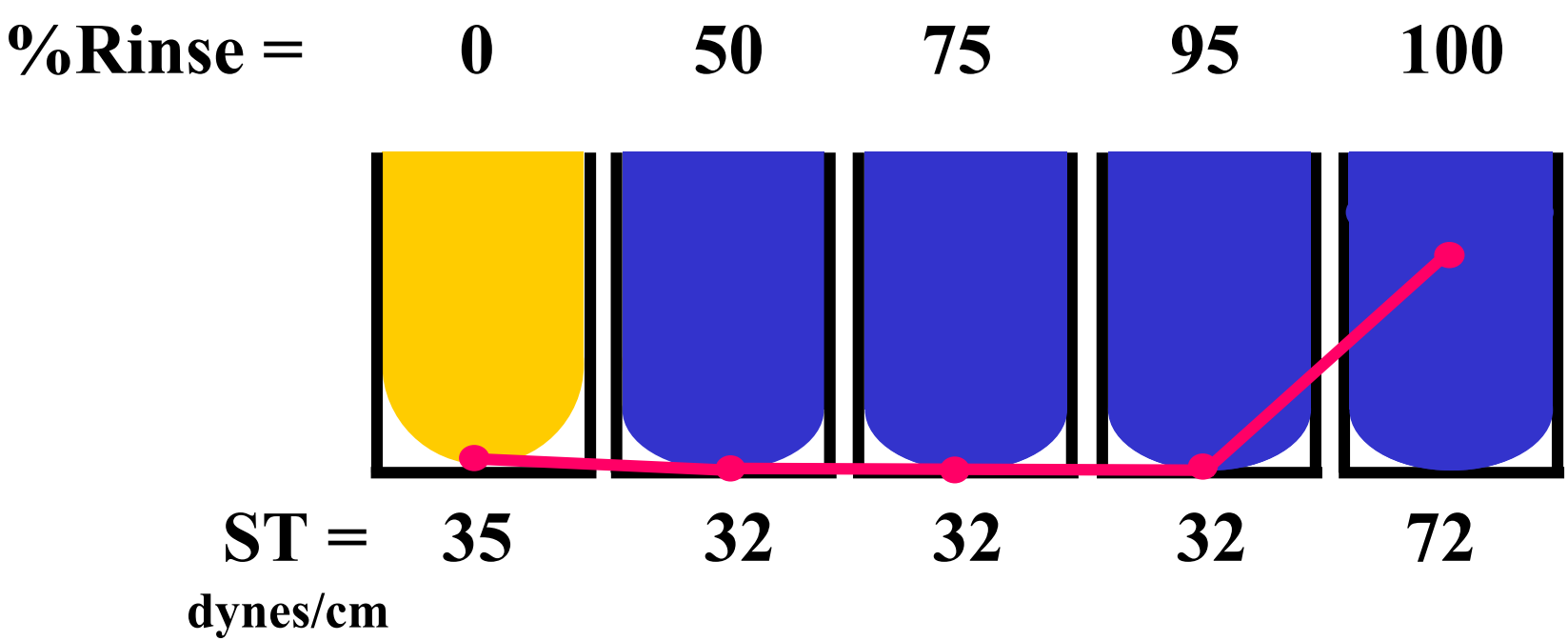


ST = dynes/cm	42	50	55	67	72

GenClean™ Rinse Model

Surface Tension vs Mixing

GenSolve™/ GenClean™ Rinsed with DI Water

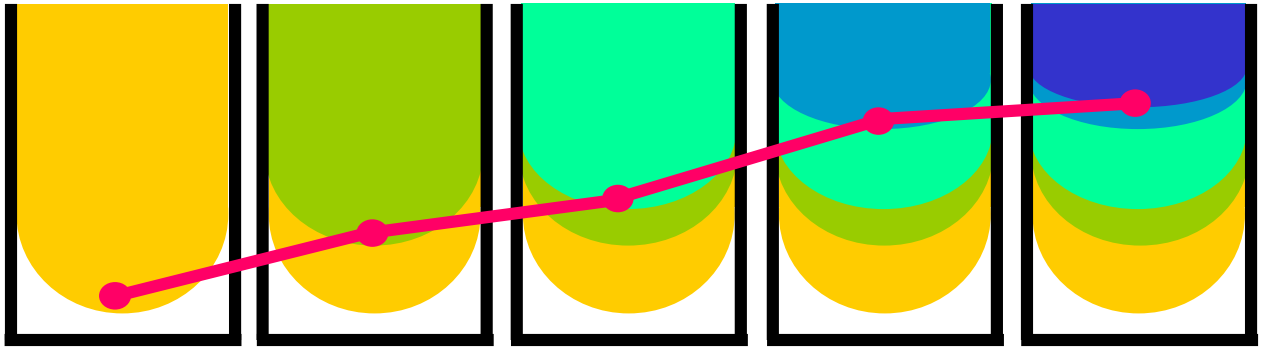


GenClean™ Rinse Model

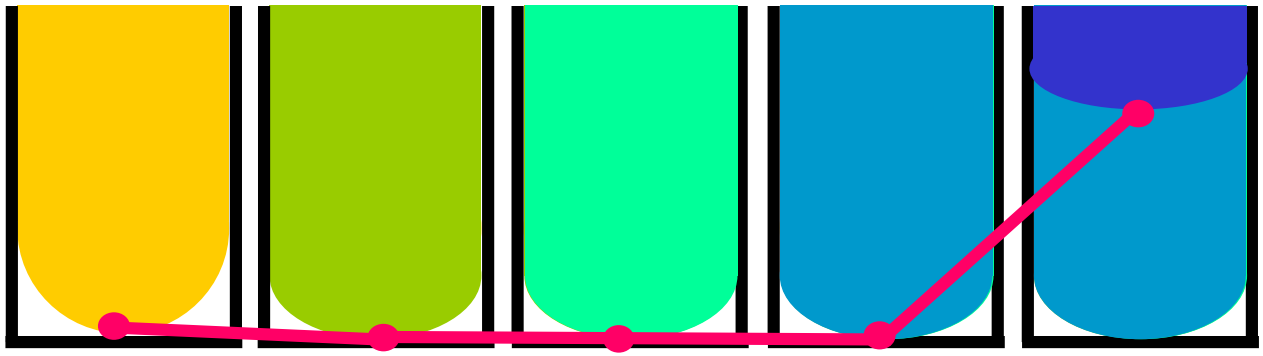
Surface Tension vs Mixing

%Rinse =	0	50	75	95	100

Solvent



Blend w/ST Aid



GenClean™ Emulsification

Polymer Solubilization

Chemistry	0.5% Resist	1% Resist	10% Resist
AQ-805	Clear	Cloudy	Cloudy, ppt
AQ-805 *	Clear	Clear	Cloudy, ppt
DI Water	Cloudy	Cloudy	Cloudy, ppt

* increased concentration of active species

Summary

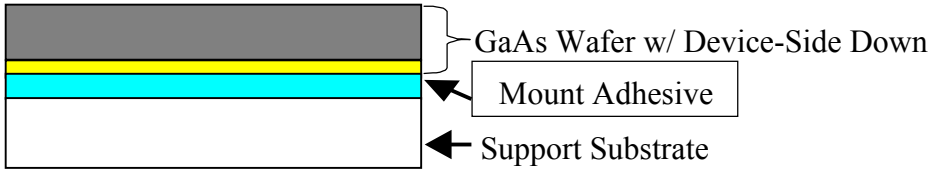
Thick Film Resist Removal

- Design Robust processes (maximize slope, minimize bridging, minimize metal contact, minimize temperature)
- Know your resist - match the chemistry
- Choose a stripper having selectivity and life
- Use agitation and filtration
- Choose rinse methods for performance and life

A New Adhesive for Substrate Thinning and Processing

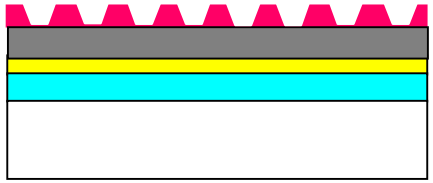
III-V Thinning & Backside Processing

①Mount

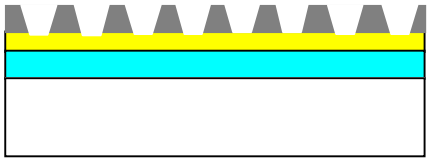


②Thinning

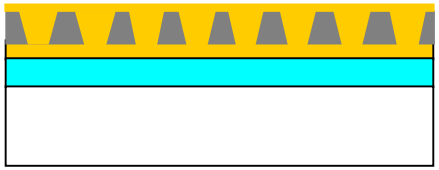
③Photolithography



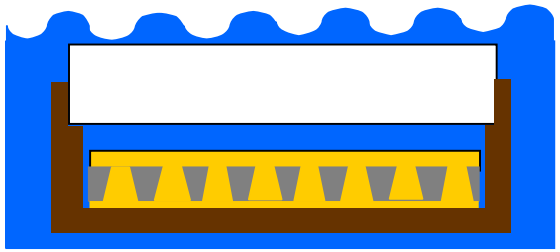
④Backvia Etch & Cleans



⑤Metallization



⑥Demount



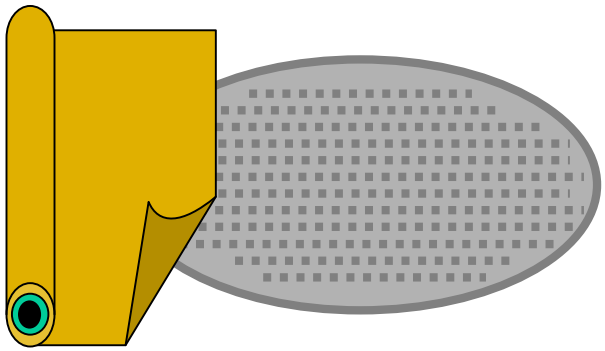
Temporary Adhesive Development

Goals and Objectives

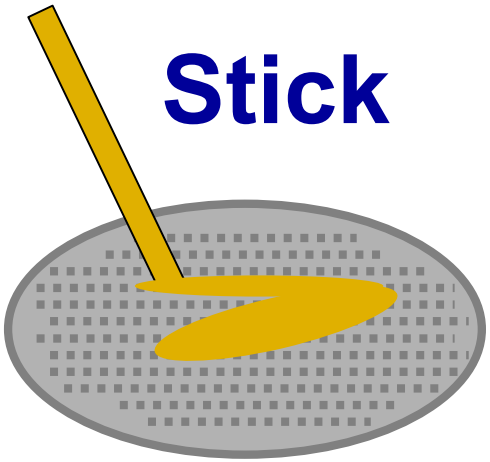
- Application Uniformity
- Mounting Uniformity
- Mounting voids(bubbles)
- Chemical Compatibility
- Short De-mount Times
- Residue Formation

Adhesives currently in-use

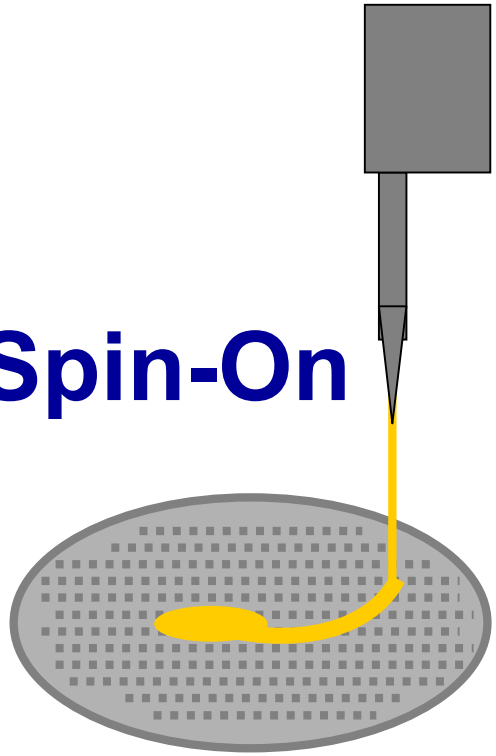
Dry-Film



Stick



Spin-On



Adhesive application

Application		Uniformity
Stick		Irregular, Lg. Voids
Dry-Film		Voids +/- 5%
Spin-On		Pentalyn™ +/-15%
Spin-On		GenTak™ +/-0.3%

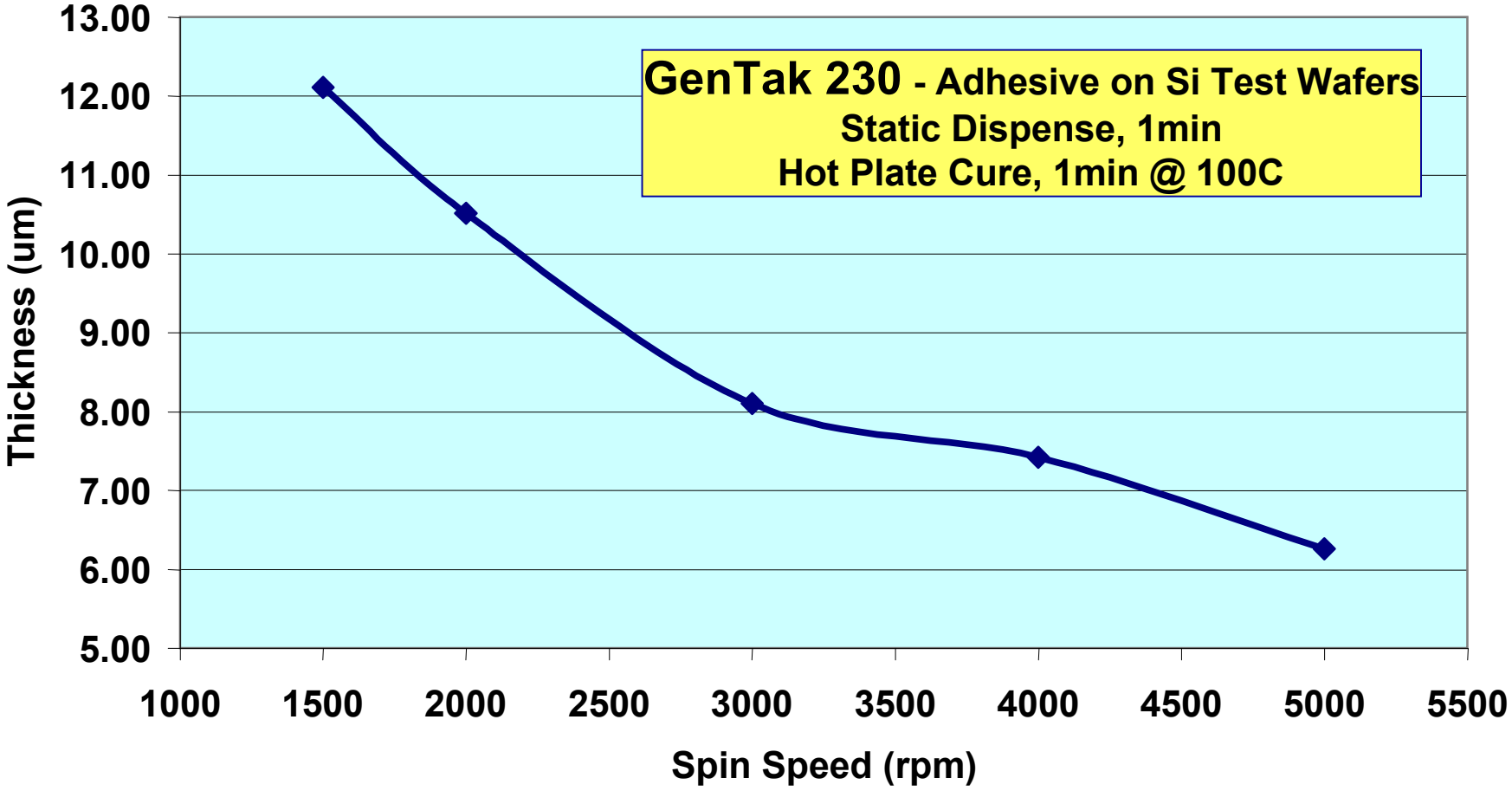
Temperature Stability

GenTak™	Type	Temp. Stability °C
230	Thermoplastic	≤130
HT-300	Thermoset	>200

Stability - Thermal stability, softening, etc.

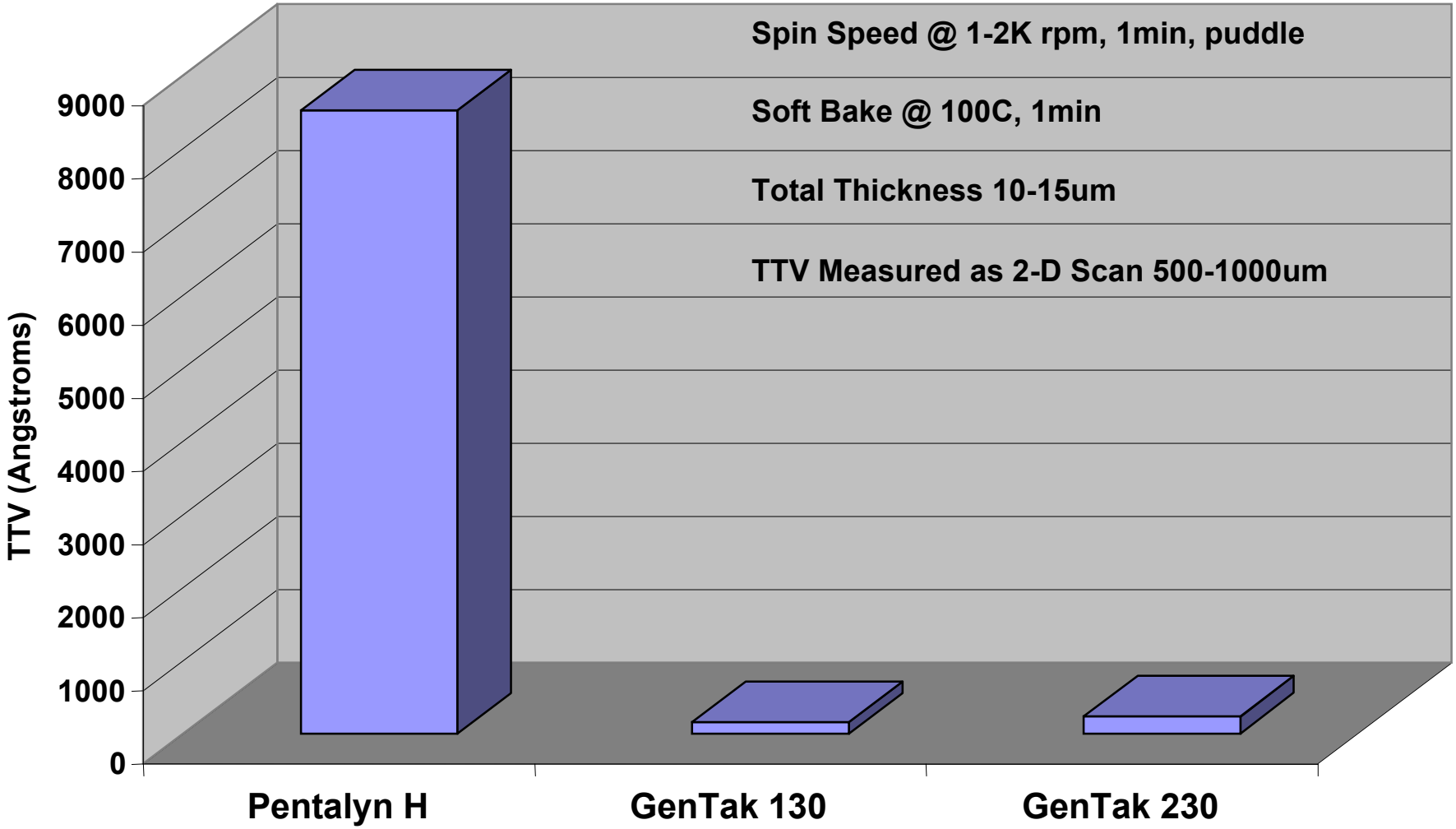
Coating on Smooth Substrates

Thickness vs. Spin Speed



Total Thickness Variation (TTV)

Spin-On Adhesive Thickness vs Product Type



GenTak™ Spin-On Adhesive Coating and Mounting Model

GenTak™ Layer 1
Wafer with Topography

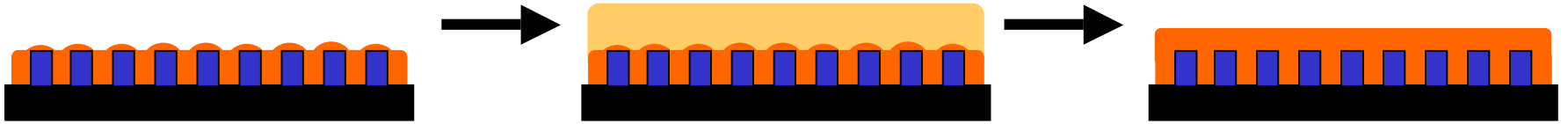
Spin-Coat on Wafer
Penetration and Protection

Cure - Soft + Hard Bake
Drive-Off Volatiles, Planarize

GenTak™ Layer 2
Planarized Wafer Surface

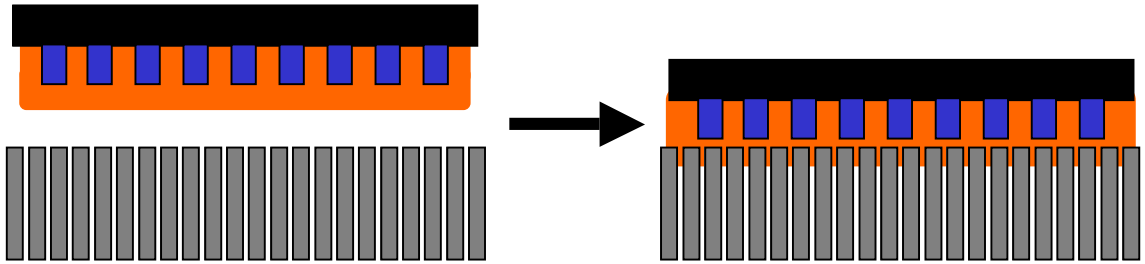
Spin-Coat on Wafer
Establish Mounting Layer

Cure - Soft + Hard Bake
Planarization and Thickness

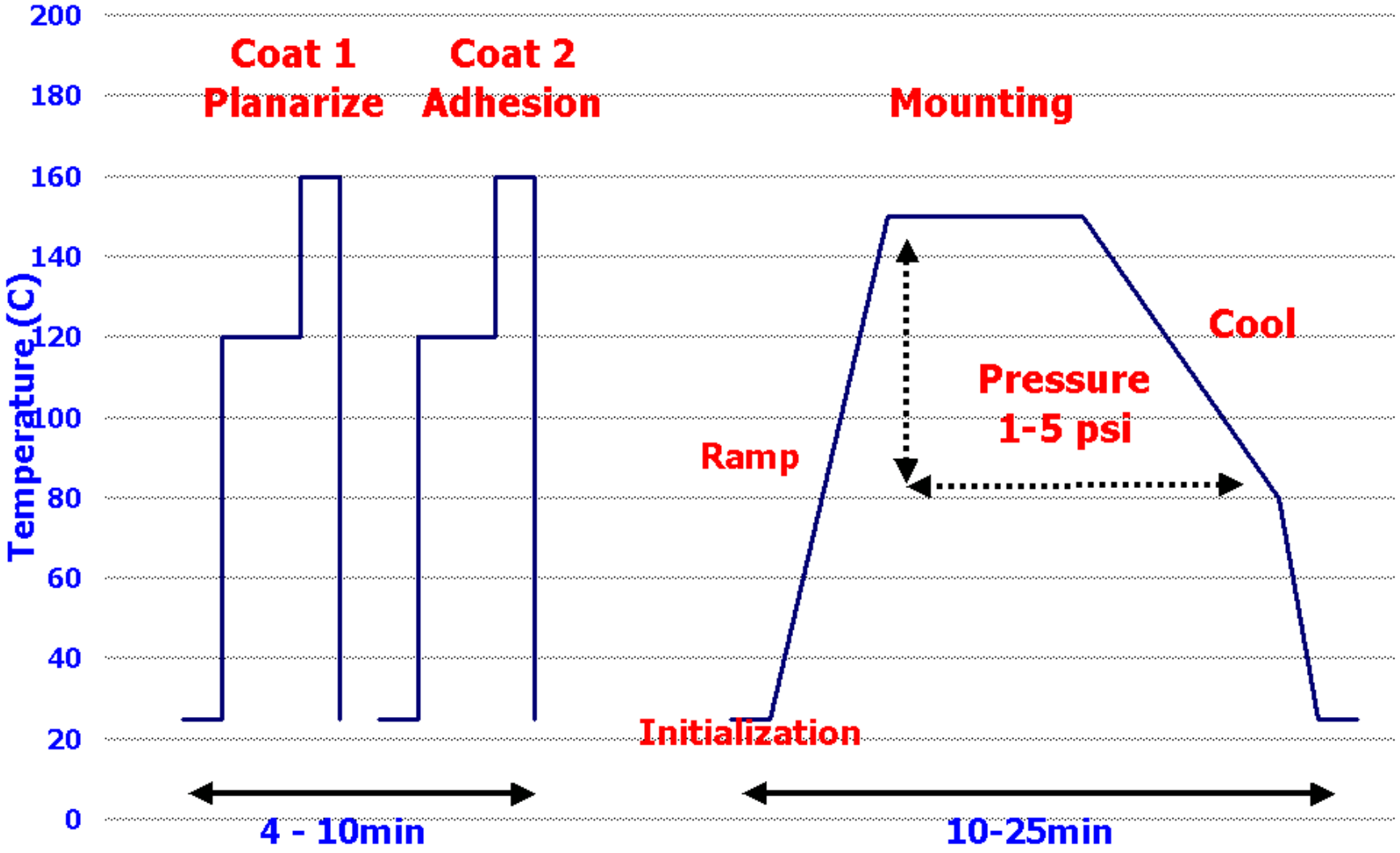


Mounting
Adhesion to Perforations

Heat + Pressure
Maintain Pressure to Cooling

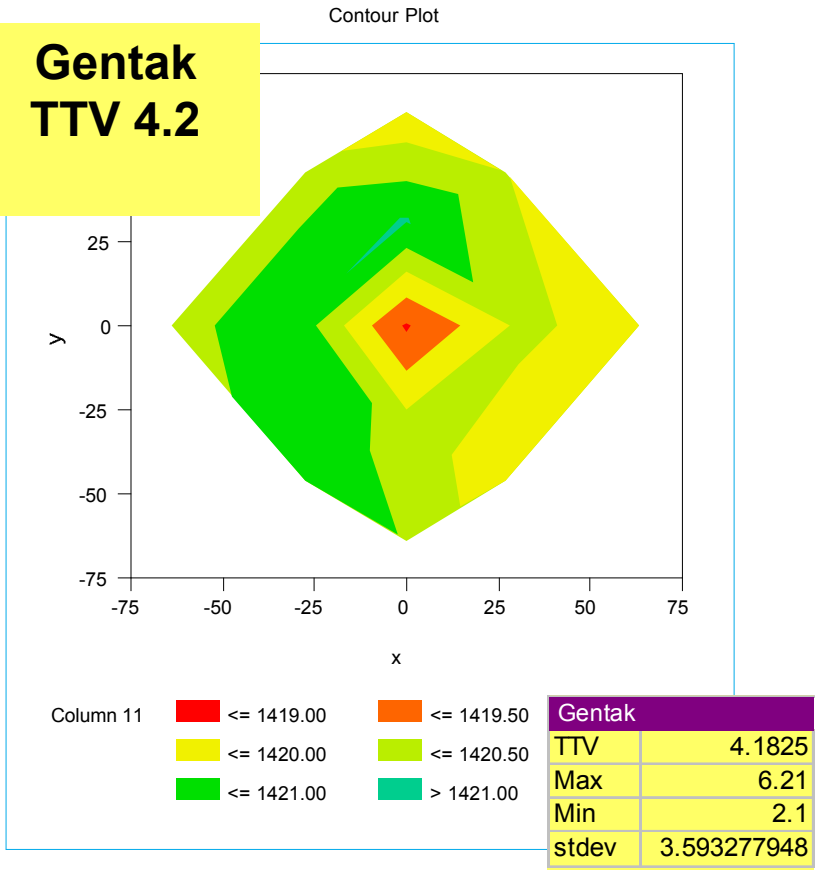


GenTak Application & Mounting



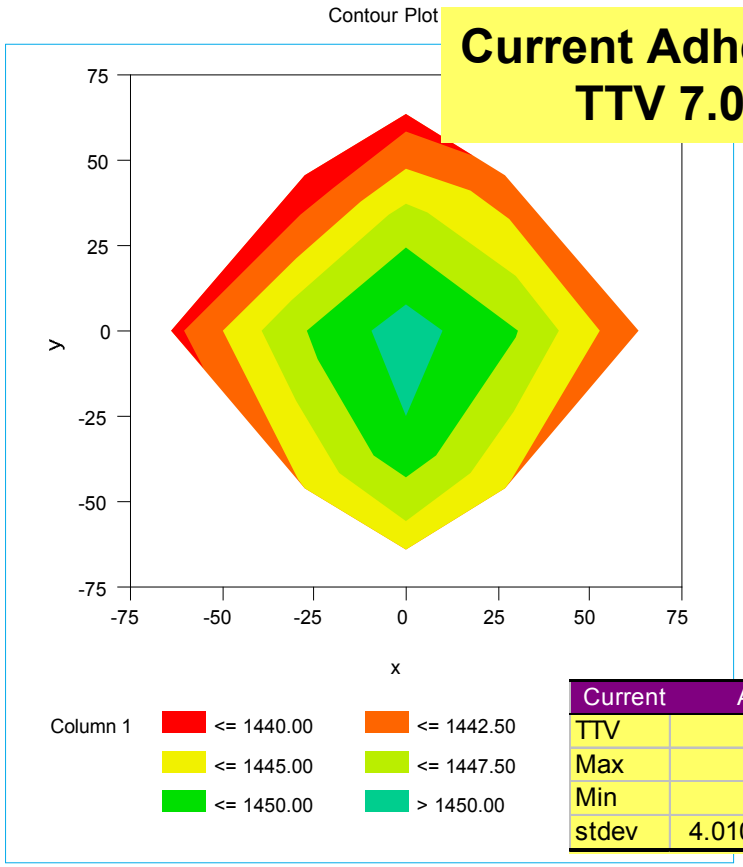
Pkg TTV - GenTak vs. Current Adhesive

Gentak
TTV 4.2



Gentak	
TTV	4.1825
Max	6.21
Min	2.1
stdev	3.593277948

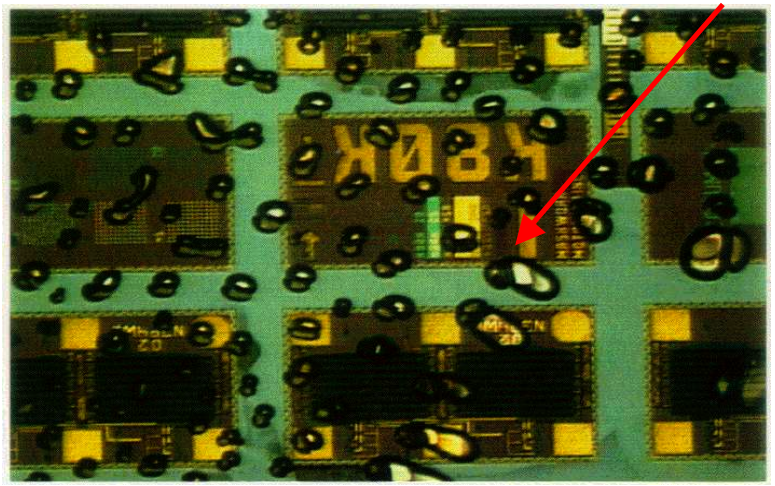
Current Adhesive
TTV 7.0



Current	Adhesive
TTV	6.9675
Max	13.53
Min	4.35
stdev	4.010443357

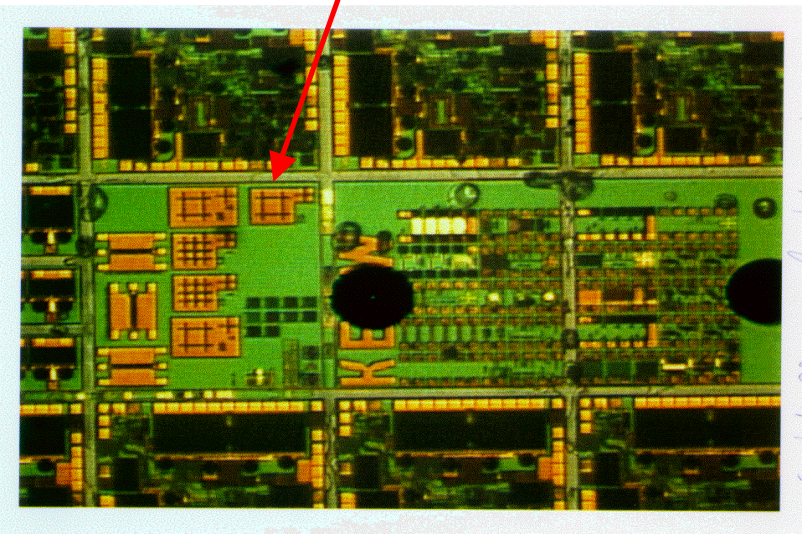
Uniformity and Clarity

Current Adhesive-bubbles through sapphire



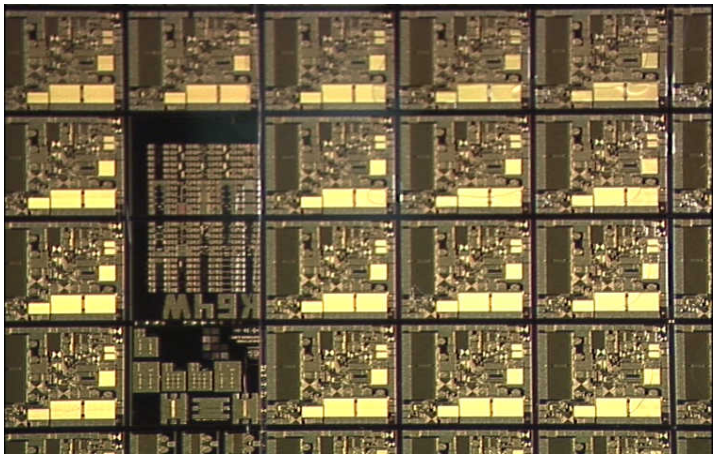
GenTak ™ 230 through sapphire - Very few bubbles

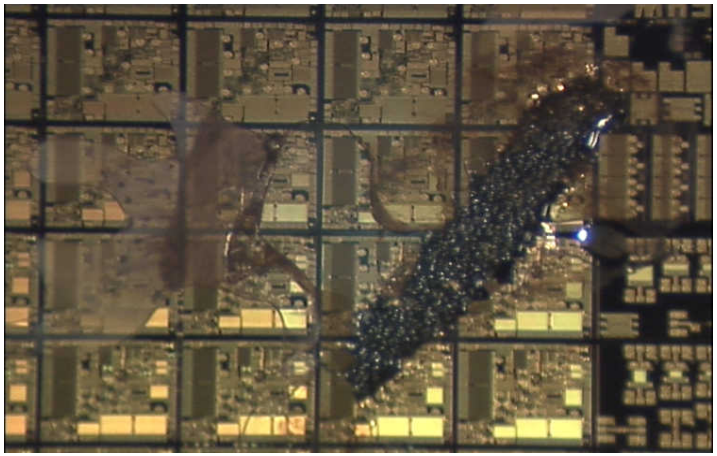
Notice clarity of alignment marks!



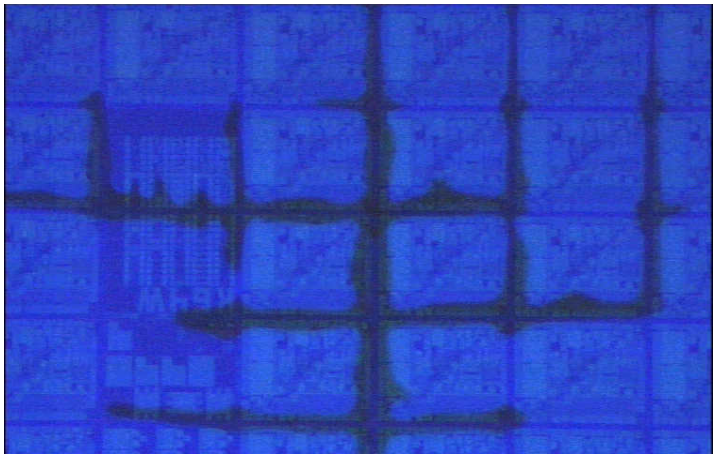
GenTak™ - Observable UV Tool

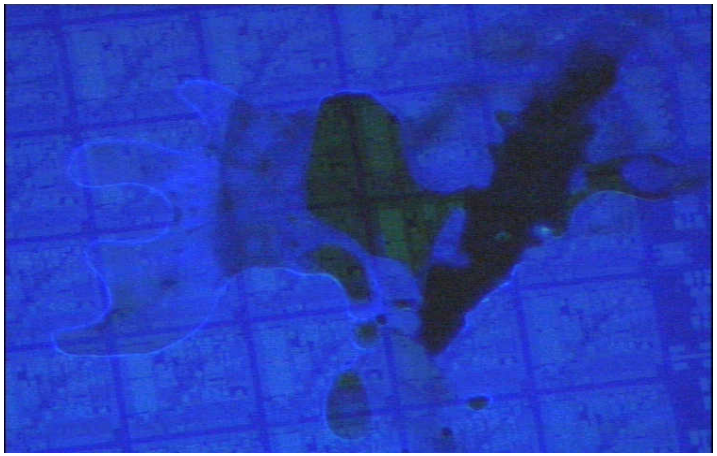
Visible Light





UV Light





Chemical Compatibility

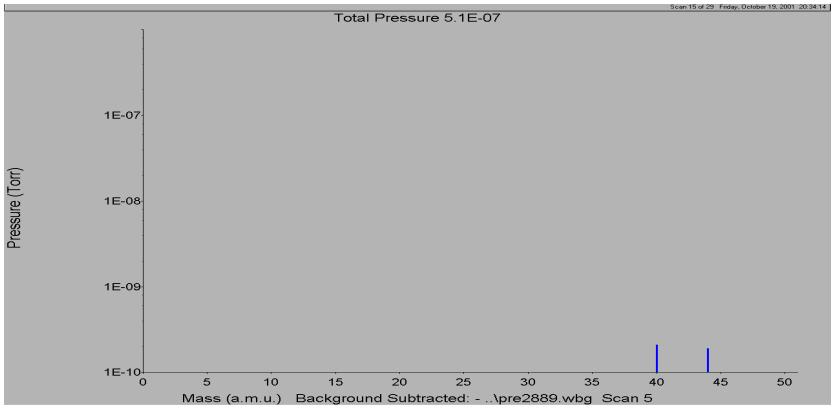
Chemical	GenTak™ 230	GenTak™ HT-300
H2SO4, 6N	NE	NE
HCl, 6N	NE	NE
H3PO4, 20%	NE	NE
HOAc, 20%	NE	NE
H2O2, 15%	NE	NE
NaOH, 10%	Effect	NE

NE - No Effect

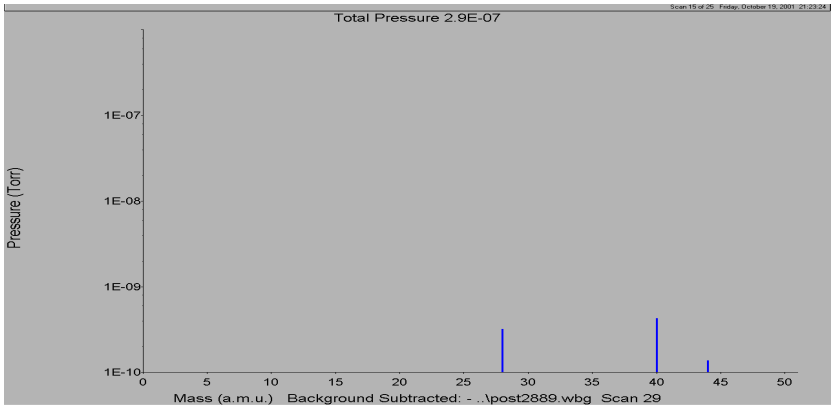
Adhesive Development

Out-gassing At Metals Deposition Process

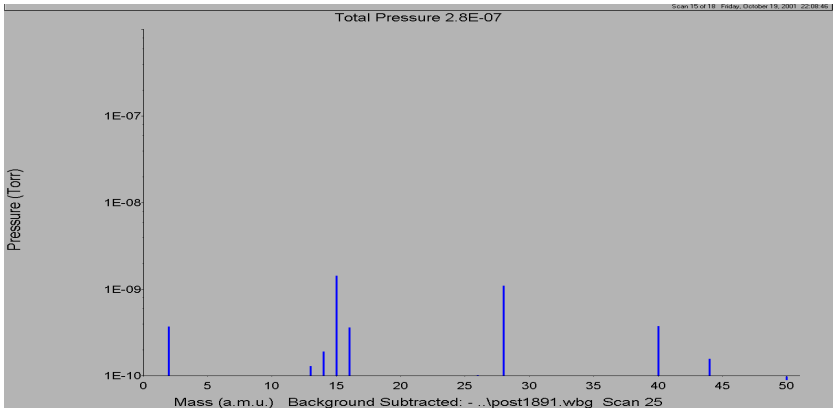
GenTak™



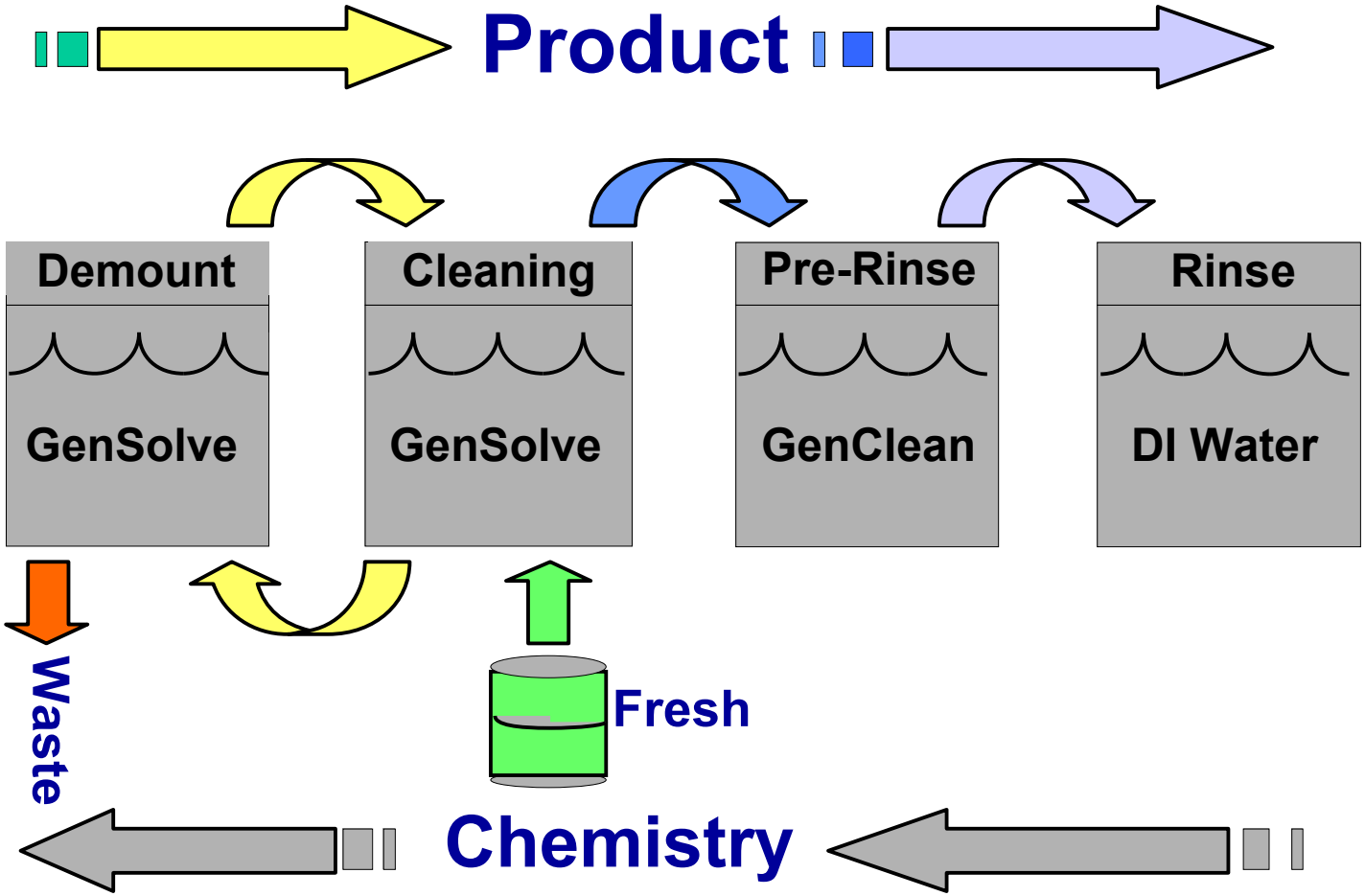
GenTak™



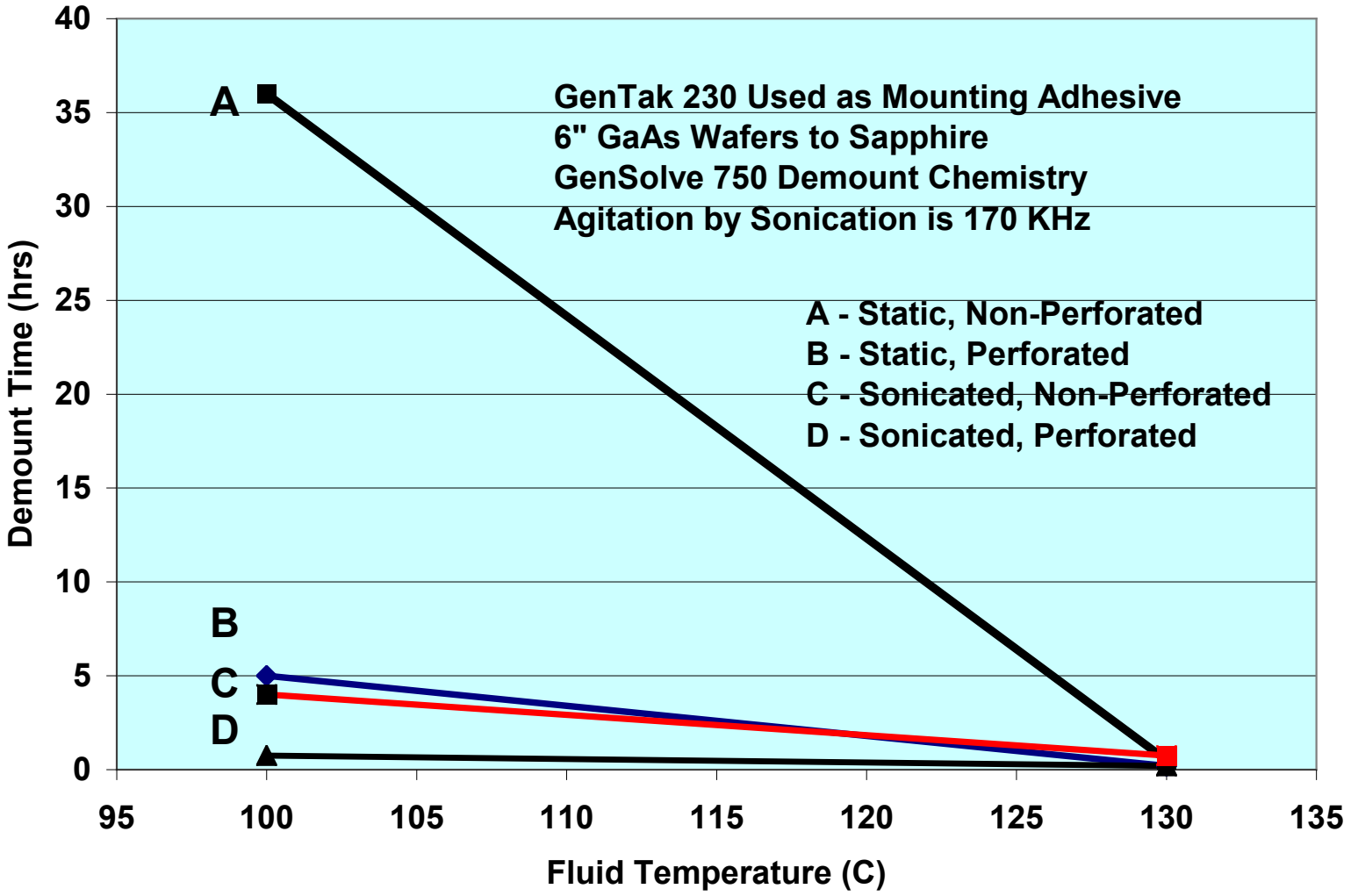
Current Adhesive



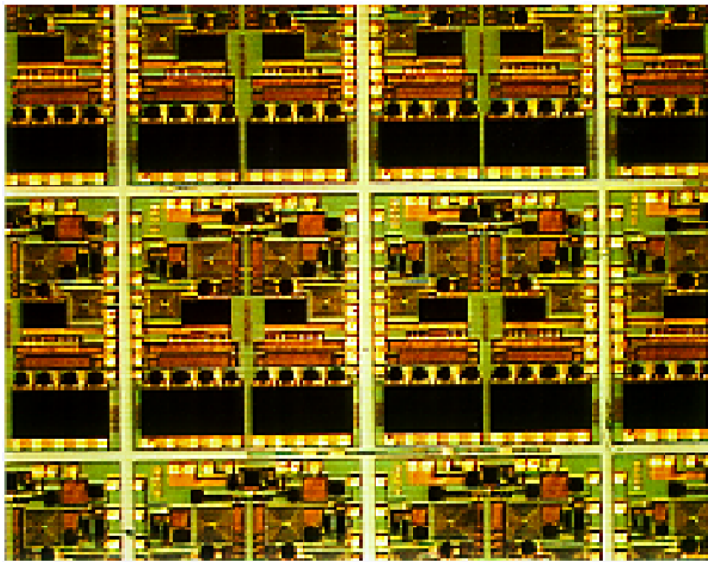
Demount and Clean Process



Demount Results

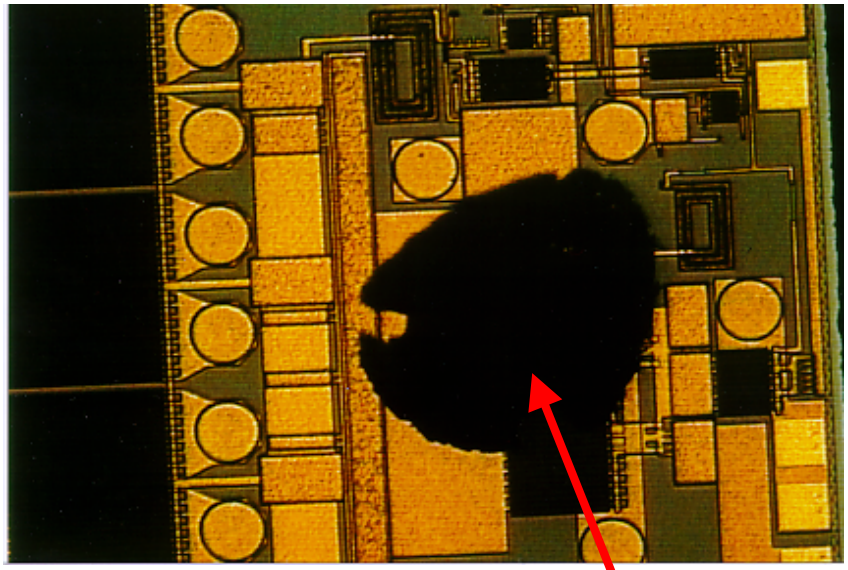


Residue Formation



GenTak™ 230

Notice lack of residue!



Film Adhesive

Residue!

Summary

A New Adhesive for Wafer Thinning and Processing

- Rapid application
- Adhesion to a variety of substrates
- Uniformity and Thickness Control
- Bubble-free bond - UV Tool
- Compatible - broad range of chemicals
- Rapid Demount from Carrier
- Demount Chemistries - Safe for Metals
- No Residue Formation

Acknowledgments

- Alex Smith, General Chemical
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