Washable Coatings for Packaging Practices

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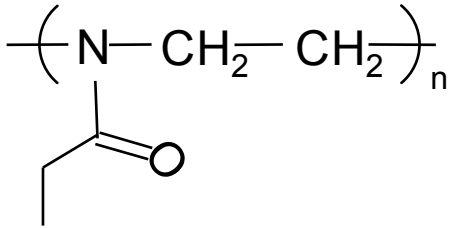
Washable Coating Defined

- Includes temporary coatings & adhesives
- Performs work function
- Removes without substrate compromise
- Washing includes water, detergent or non-hazardous solvents
- Washing conditions extremely mild, safe for devices, materials, or tape
- Match washable coating to process conditions

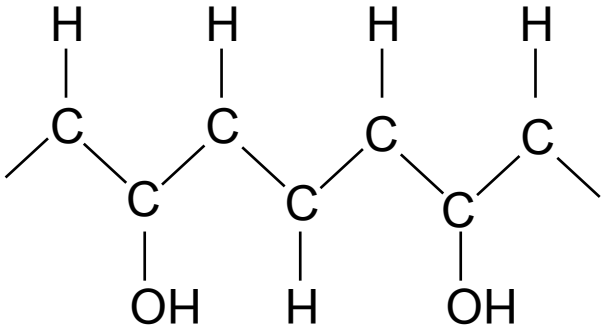
Chemistry of Washable Polymers

- Good Barrier Qualities
- Excellent Film Forming
- Extremely Water Soluble
- High Polymer Compatibility

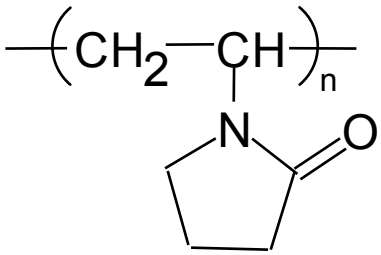
Polyoxazoline (PEOZ)



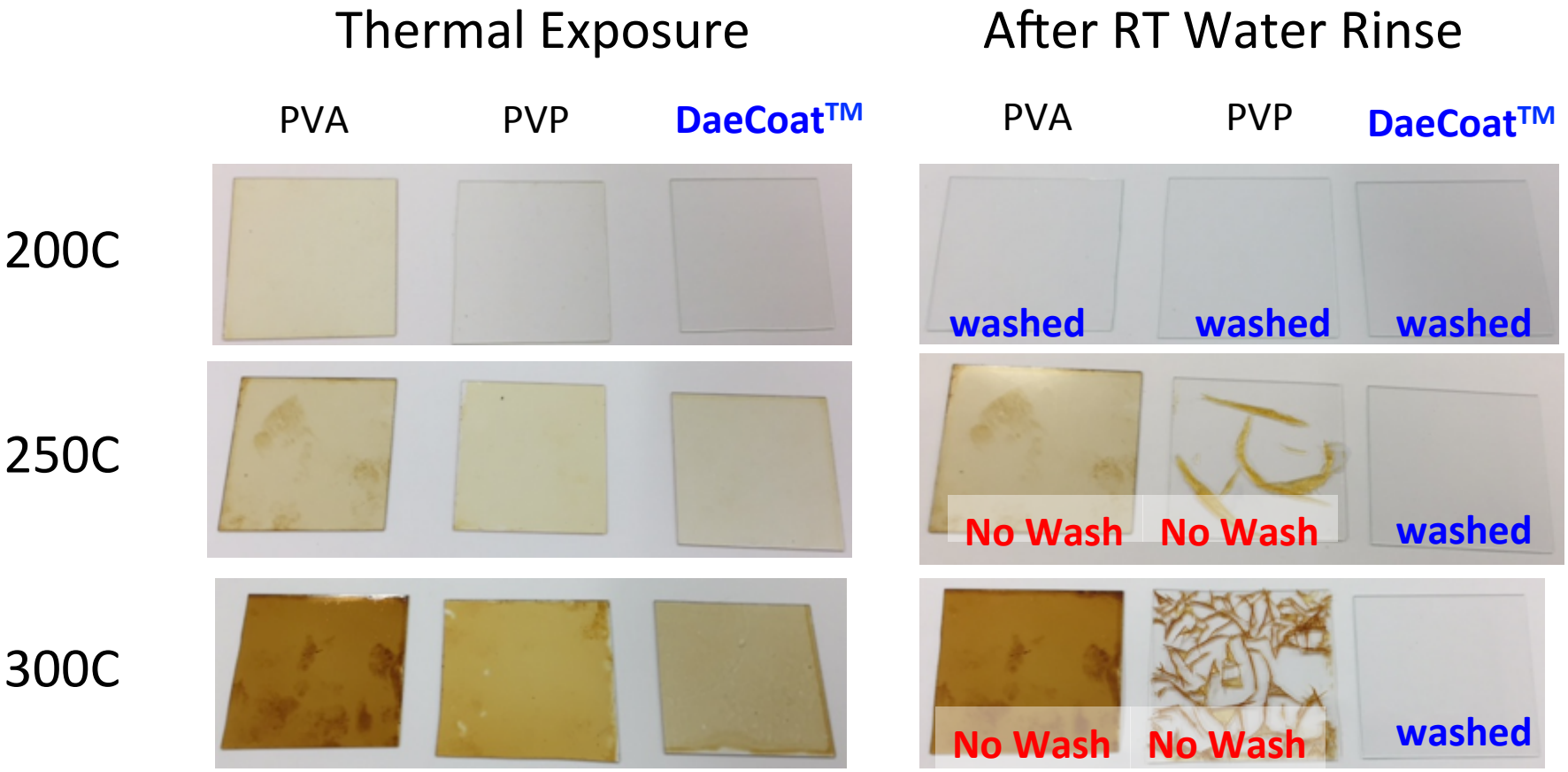
Polyvinyl Alcohol (PVA)



Polyvinyl Pyrrolidone (PVP)



Thermal Resistant Washable Coatings



PVA/PVP is resistant/washable to low temp; If on metal, temp <<150C.
DaeCoat™ is resistant/washable to >>300C.

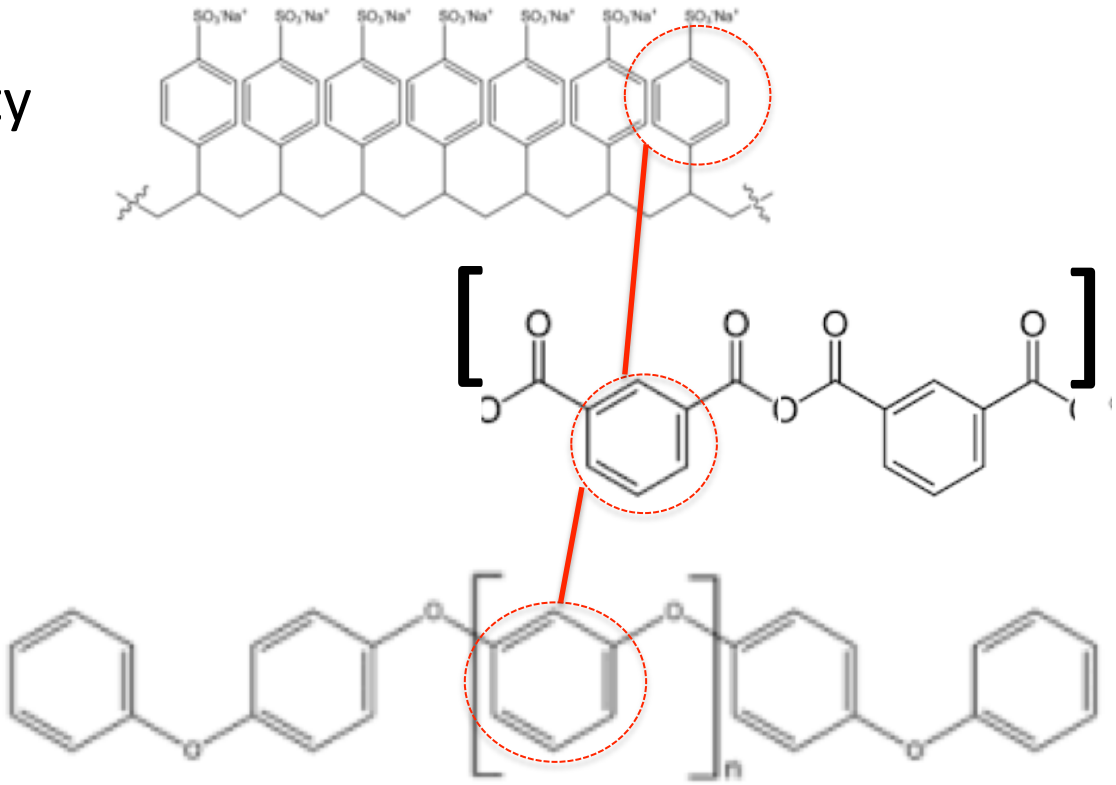
Improved Thermal Resistance

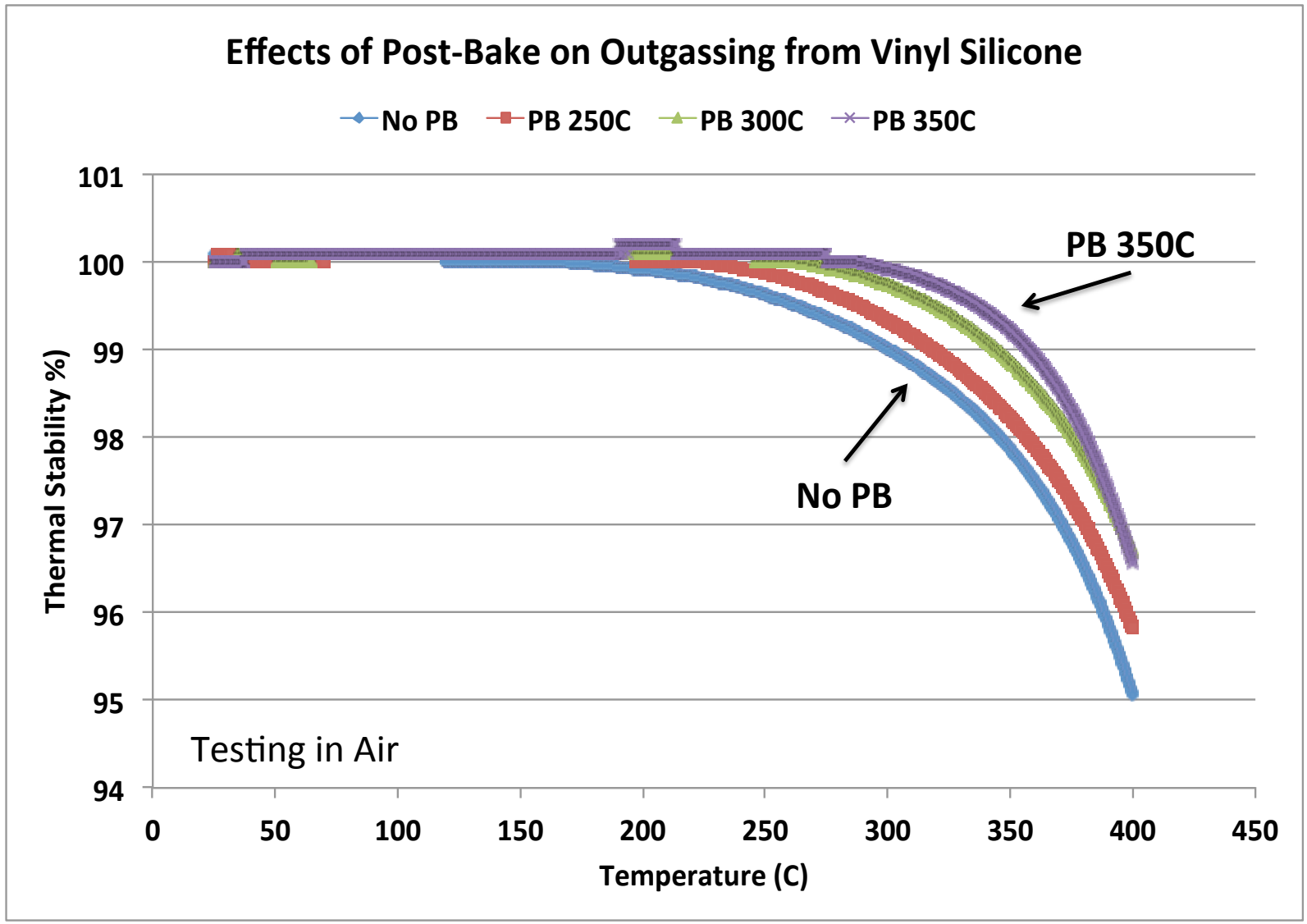
Thermal Resistance

- Chemical functionality
  - Phenyl
  - Polyester

DaeCoat™ Systems

- Phenyl silicones
- Polyphenylsulfones
- Salt conjugates




Effects of Post-Bake on Outgassing from Vinyl Silicone
No PB
PB 250C
PB 300C
PB 350C
Thermal Stability %)
101
100
99
98
97
96
95
94
PB 350C
No PB
Testing in Air
0
50
100
150
200
250
300
350
400
450
Temperature (C)

Ex.: Wafer Temporary Bonding

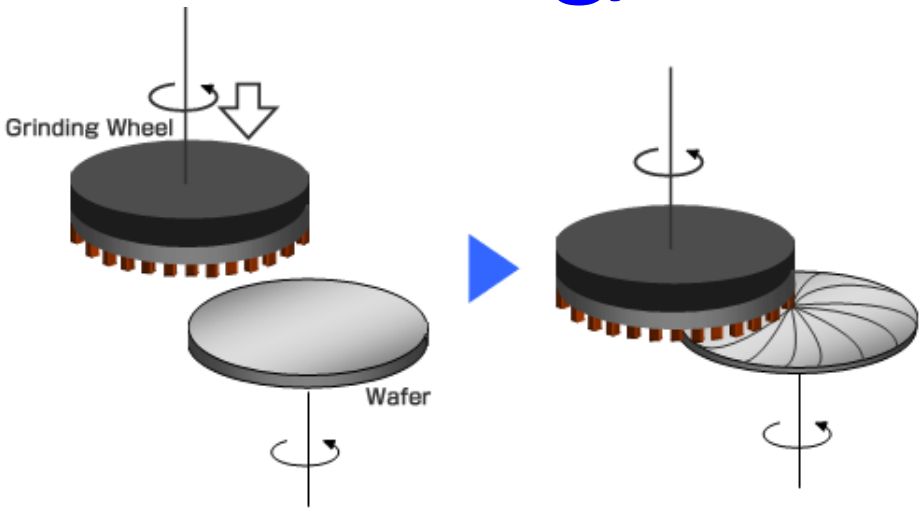
Process Demand

- **Objective:** Wafer thinning, backside processing
- **Mechanical (e.g. grind):** Yes
- **Thermal resistance: <**300C
- **Process/chemicals:** Yes
- **Uniformity:** ~2um

Recommendation

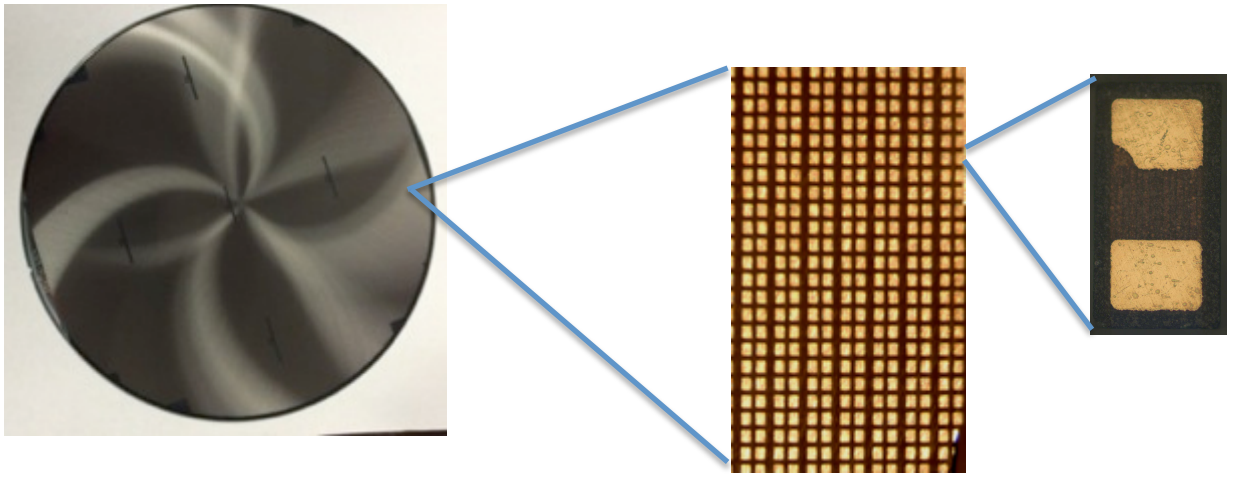
- **DaeCoat™ 355**
  - Green solvent washable, DaeClean™ 300
  - Broad chemical resistance
  - Thermal resistance: >300C
- **Carrier:** Solid, due to small die, simple release/cleans
  - chemical diffusion
  - recycled

Thinning, Processing, Release

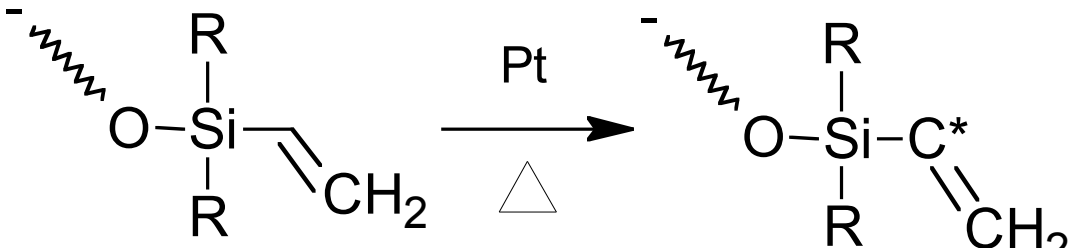


Grinding, backside processing, singulation

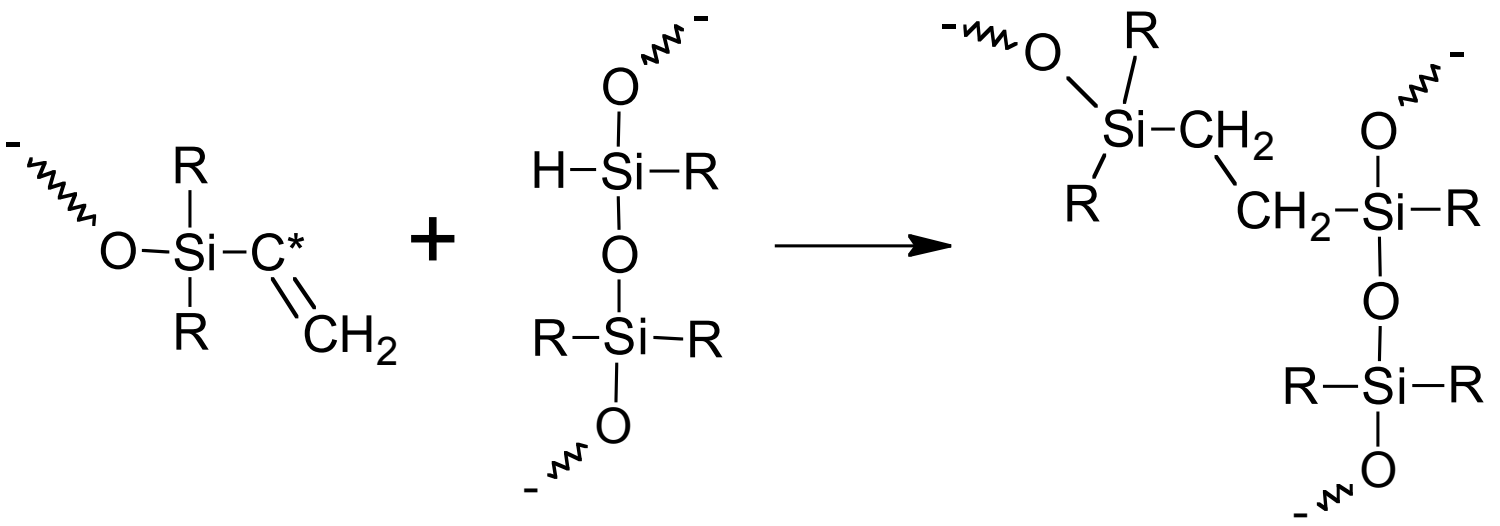
Singulation offers 1-2mm channel between devices to enable simple debond & wash



Silicone Thermoset (catalytic)

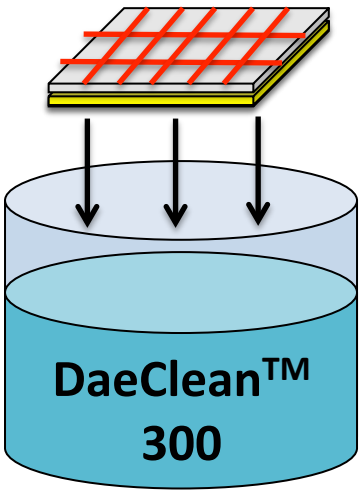


Resin monomer (MW & shape) **Free-Radical**

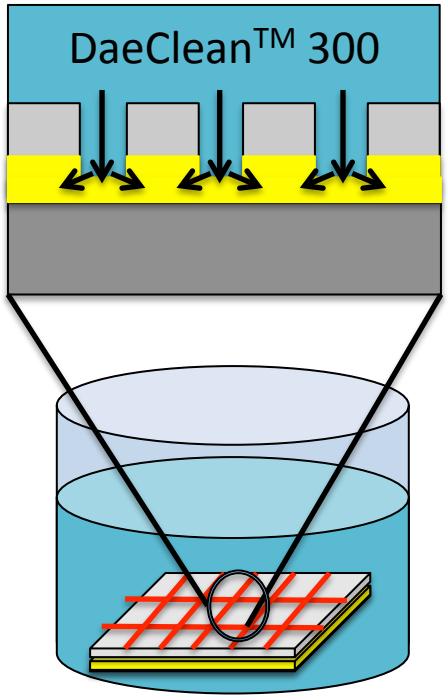


Activator monomer (MW & shape) **Silicone Polymer**

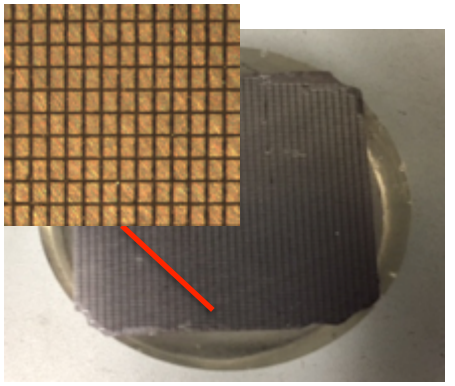
Green Solvent Wash Adhesive



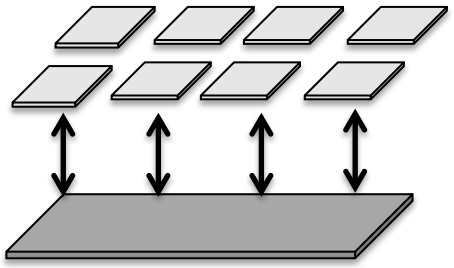
Immersion



Adhesive Dissolution



Device:
Capture/Further Processing



Carrier Release/Recycle

Ex.: Wafer Planarization

Process Demand

- **Objective:** Wafer planarizing coating for backside processing
- **Mechanical (e.g. grind):** No
- **Thermal resistance:** <300C
- **Process/chemicals:** Yes
- **Uniformity:** <5%
- **Special:** Desire to finish on FF tape

Recommendation

- **DaeCoat™ 357**
  - Green solvent washable, DaeClean™ 300
  - Broad chemical resistance
  - Thermal resistance: >300C
- **Carrier:** desire FF tape
  - Safe for DaeClean™ 300

Planarization Coating

Wafer with Topography (planarize >100um)

Planarization Coating

Planarized Surface

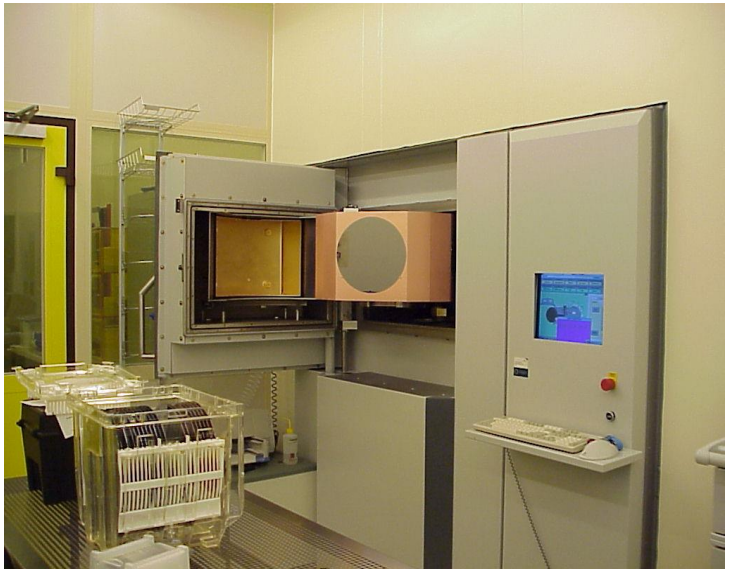
Washable Planarization Coating

Sputtering Test

- Sputter deposition of 200nm Ti:W + 300nm Copper on 250µm thick DaeCoat™ 357 using LLS802 multi target tool

wafer with 100:1 mix ratio after sputtering

wafer with 50:1 mix ratio after sputtering



Chamber Capability:
24 x 4" - 6" wafers per batch
8 x 8" wafers per batch
4 x 300 mm wafers per batch

Ex.: Device Temporary Bonding

Process Demand

- **Objective:** LTCC flip-chip bond & encapsulate
- **Mechanical (e.g. grind):** No
- **Thermal resistance:** ~275C
- **Process/chemicals:** limited, RT flux cleaner
- **Uniformity:** <10%

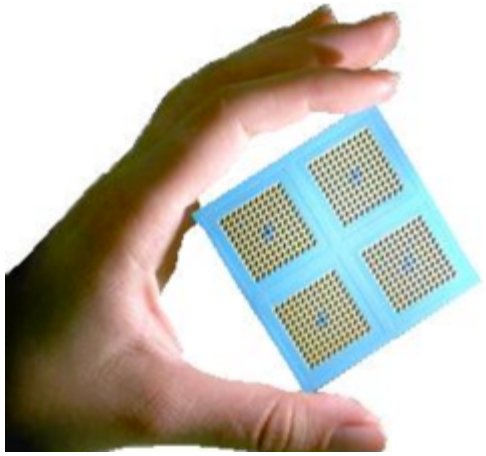
Recommendation

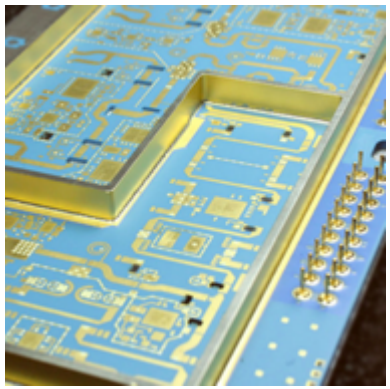
- **DaeCoat™ 537***
  - Hot DIW washable
  - RT chemical resistance
  - Thermal resistance: >300C
- **Carrier:** Porous
  - chemical diffusion
  - Recycled
- **Cleans:** Surfactant in DIW
  - **DaeClean™ S10** surfactant, 2-4% in DIW, ≤80C, 5min

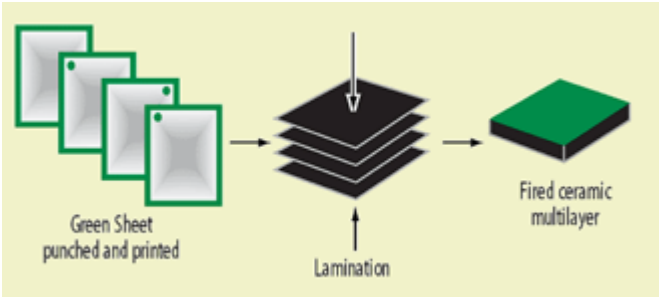
***DaeCoat™ 537 = upgraded 535**

LTCC/HTCC

- Microelectronics on a ceramic substrate
- Multi-layer packaging
- MEMS, military, RF, wireless
- Thickness <50um to >250um
- Commonly 100-150um
- Green tape – several suppliers
- Extremely fragile – handling challenge!

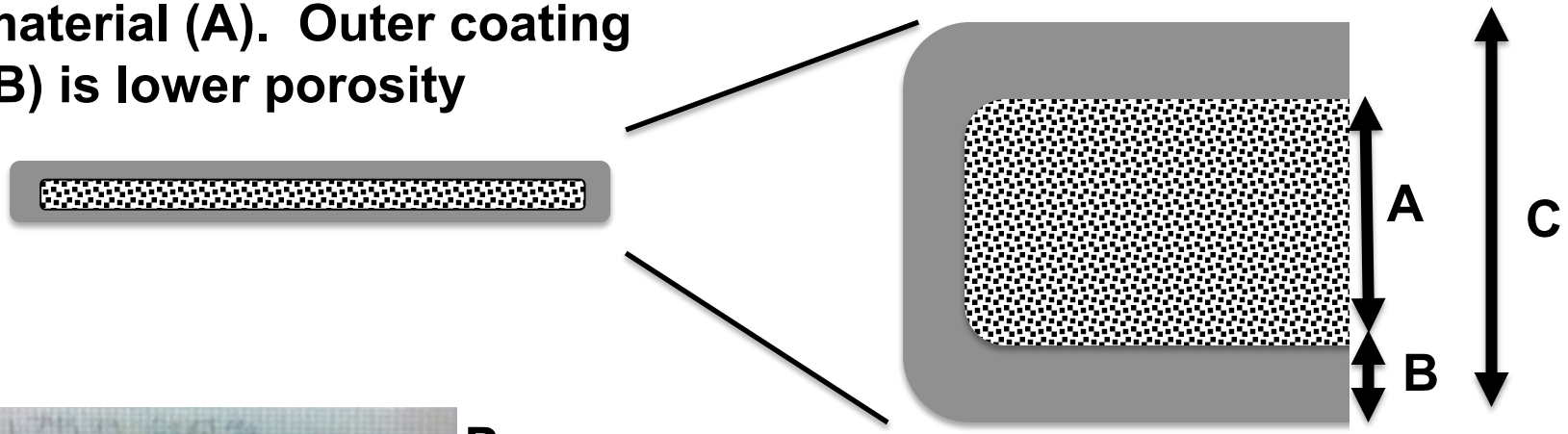


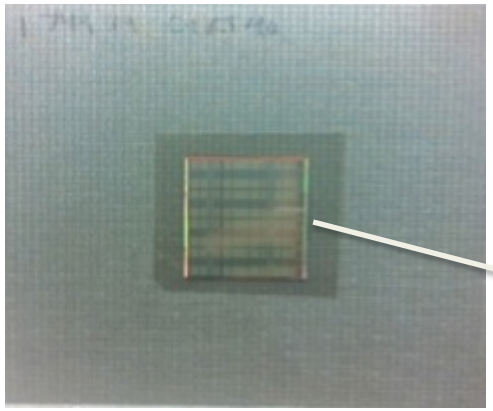




Porous Carrier

Porosity higher for inside material (A). Outer coating (B) is lower porosity



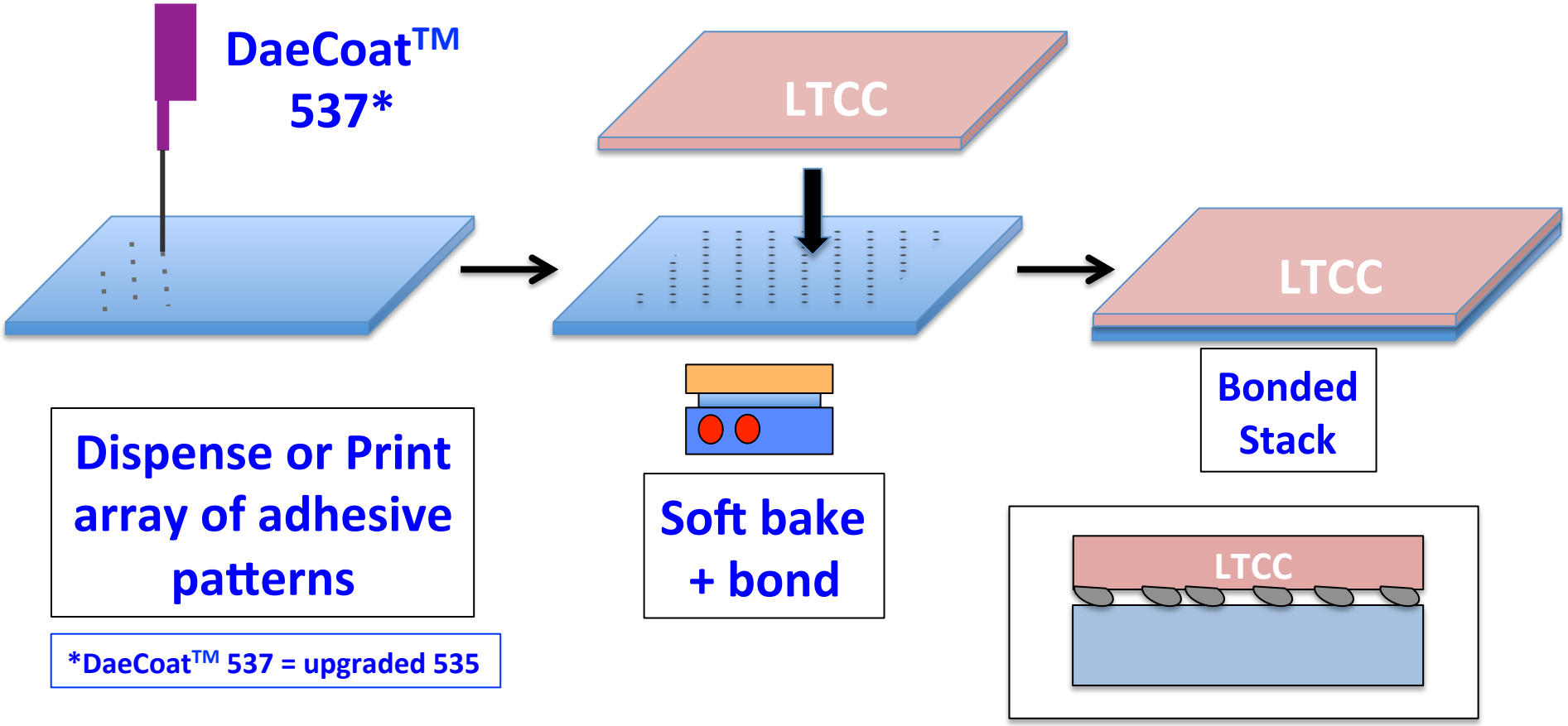


Porous Carrier

TSI on adhesive

A = 0.5 – 0.8mm
B = 0.1 - 0.25mm
C = 0.5 – 1mm

DIW Wash Adhesive for Temp Bonding



Laser Dicing Protection

DaeCoat™ 525 (water wash coating)

Process Demand

- **Objective:** Protect device topside, improve resolution
- **Mechanical:** No, laser only
- **Thermal resistance:** >300C
- **Chemical resistance:** N/A
- **Uniformity:** <5%
- **Other Uses:** protection for handling, shipping, etc.

Recommendation

- **DaeCoat™ 525**
  - Excellent uniformity, <2um
  - Cure on spin chuck, no heat
  - Coat ≤4um for laser applications
  - Thermal resistance: >300C
  - Water washable (DIW)
  - RT cleans in water

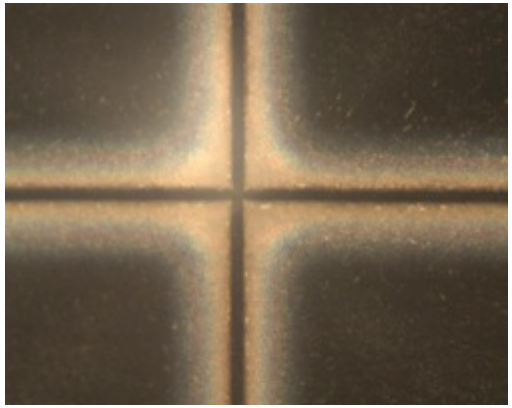
Laser Scribing & Dicing

DaeCoat™ 525 (water wash coating)

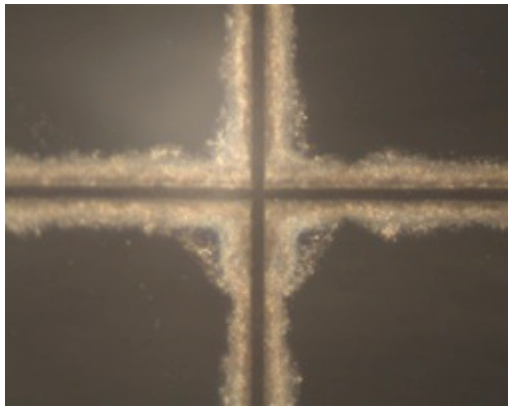
Integrated UV Marking Solution
< 700 Watt Single Phase
Model 3500 Series 355 nm Laser
Materials Can Be Marked, Engraved, Scribed, Cut Or Drilled

Results (cont.)

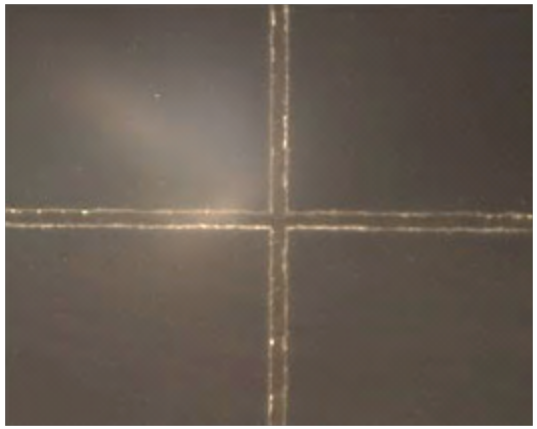
Product: DaeCoat™ 525 (water wash coating)



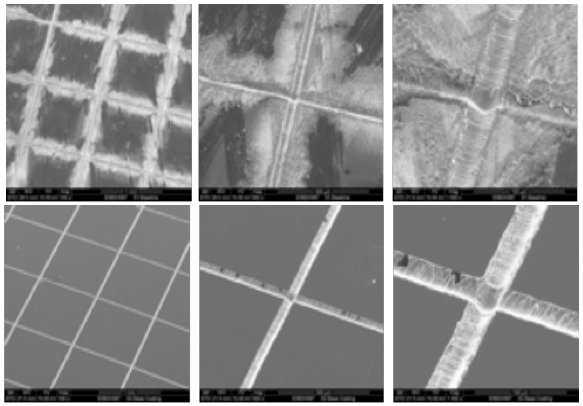
Debris



Debris, chipping of coating, residue



525 Process



No coating

W/525

Device Sawing Protection

DaeCoat™ 615 (detergent wash coating)

Process Demand

- **Objective:** Protect device topside, prevent chipping
- **Mechanical:** Yes
- **Thermal resistance:** ~150C
- **Chemical resistance:** Water, dilute acids; alkali dissolves
- **Uniformity:** <5%
- **Other Uses:** Bond/debond, + backside processing; demonstrated for III/V.

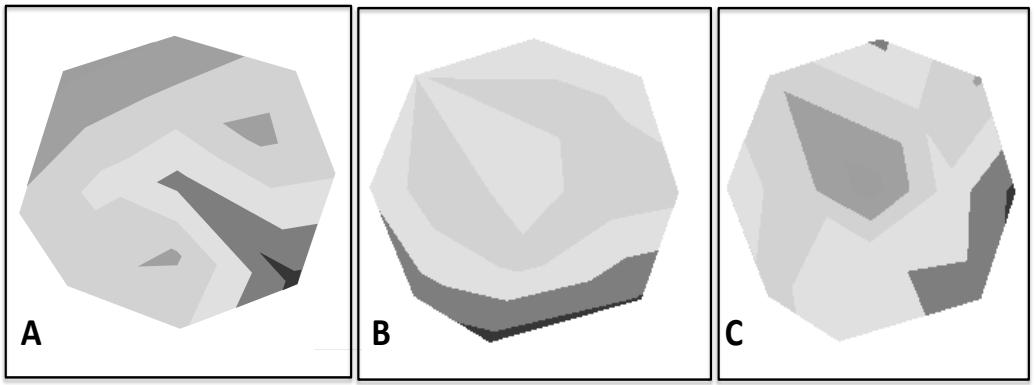
Recommendation

- **DaeCoat™ 615**
  - Excellent uniformity, <2um
  - Can be used as bond/debond
  - Thermal resistance: ~150C
  - Detergent washable (5% DaeClean 160 in DIW)
  - RT cleans in detergent

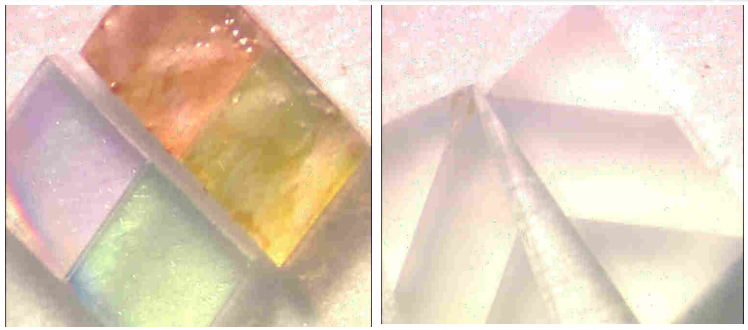
Detergent Wash Coating/Adhesive

Product: DaeCoat™ 615 (detergent wash coating)

Contour plots with 2um variation from darkest and lightest regions



Sapphire devices before and after dicing



Device Sawing Protection

DaeCoat™ 537 (Hot Water Washing)*

Process Demand

- **Objective:** Protect device topside, prevent chipping, may be used in bond/debond
- **Mechanical:** Yes
- **Thermal resistance:** >300C
- **Chemical resistance:** Water
- **Uniformity:** <5%
- **Other options:** Bond/debond, backside processing

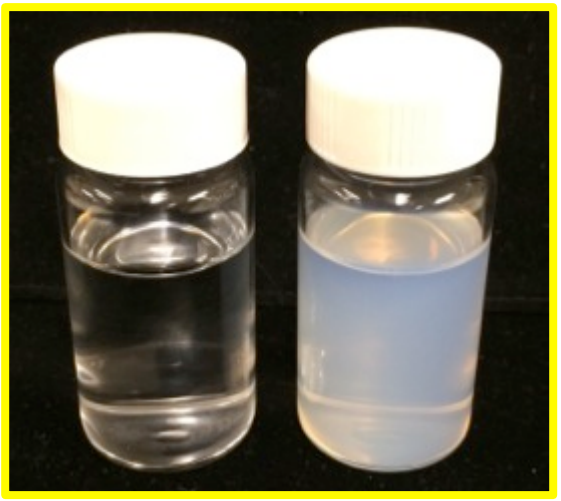
Recommendation

- **DaeCoat™ 537***
  - Excellent uniformity, <2um
  - Can be used as bond/debond
  - Thermal resistance: >300C
  - Hot water washable (2-4% DaeClean™ S10 surfactant in DIW, 60-80C)

***DaeCoat™ 537 = upgraded 535**

DaeCoat™ 537* Liquid

- 537* Liquid comprises:
  - High MW polymer;
  - Surfactant
  - DIW
- ~30% solids, viscosity <100cps
- A stable dispersion
- Neutral pH (i.e. 6-8)
- Translucent appearance

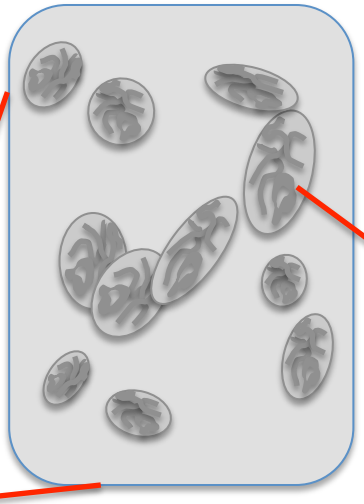


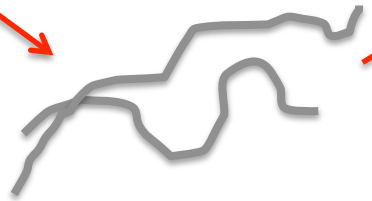
DIW 537*

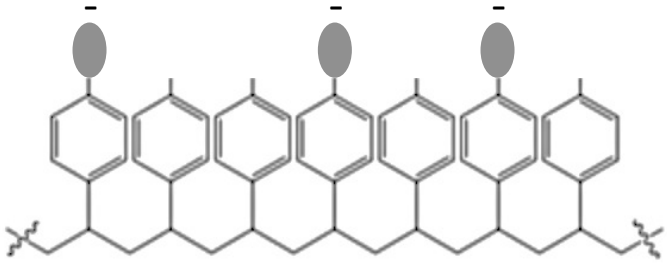
*DaeCoat™ 537 = upgraded 535

DaeCoat™ 537* Liquid

537*







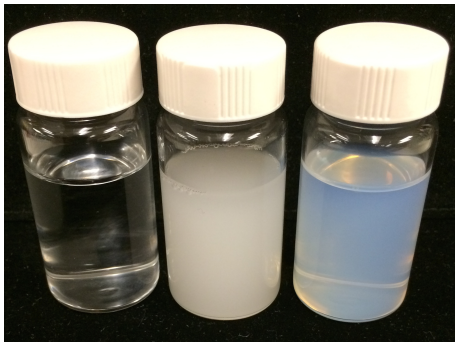
A dispersion of high MW polymers, in solution as nanometer size aggregates (20-50nm)

Phenyl functionality is phobic and provides thermal resistance. Random philic (charged) locations provide water solubility. This dual character is similar to surfactants

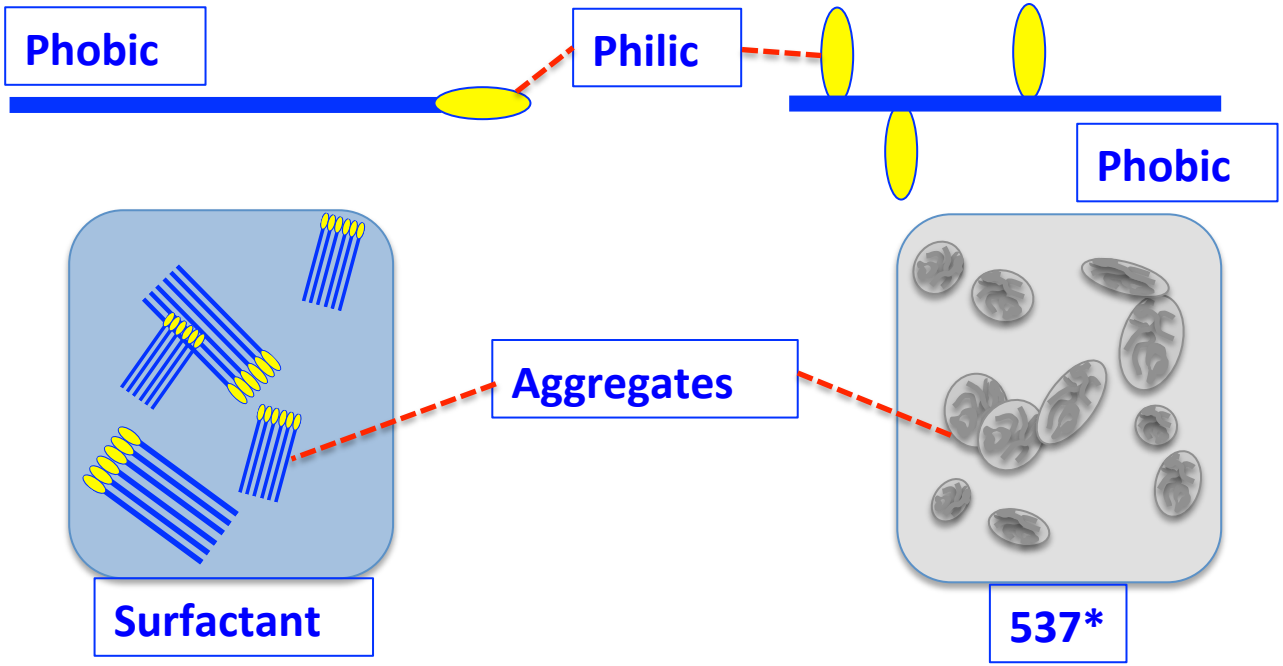
*DaeCoat™ 537 = upgraded 535

DaeCoat™ 537* Liquid

The colligative properties of the 537* are similar to a "thermal resistant" surfactant. Both have philic and phobic locations on the molecule & form aggregates in solution. Like the 537*, some surfactants are cloudy/translucent at RT.



DIW | 1% Triton* in DIW | 537*

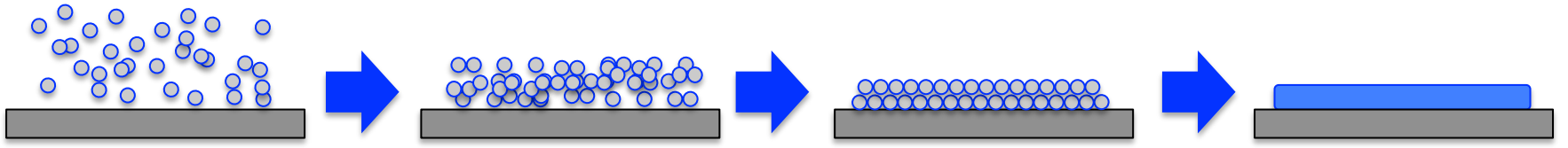


*Triton: DOW chemical surfactant.

*DaeCoat™ 537 = upgraded 535

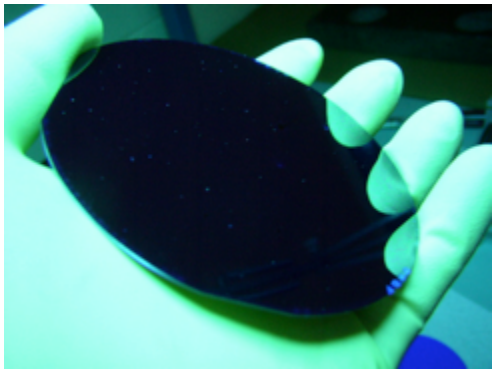
DaeCoat™ 537* Coating

Hot Water Washable



Coating & Affixing | Evaporation | Consolidation | Coalescence & Densification

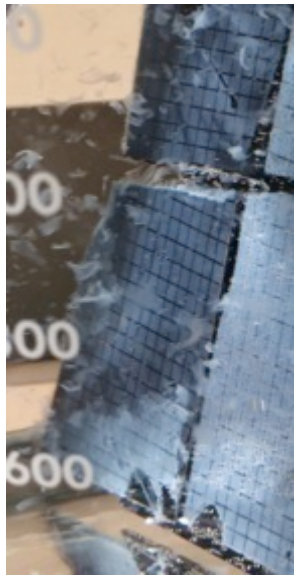
The 537* polymer system will produce very hard, glossy, and transparent coatings. The solvent (water) must be completely evaporated/removed from the system to achieve best results. The most effective way to remove water is by evaporation.



*DaeCoat™ 537 = upgraded 535

Daetec's Saw Model

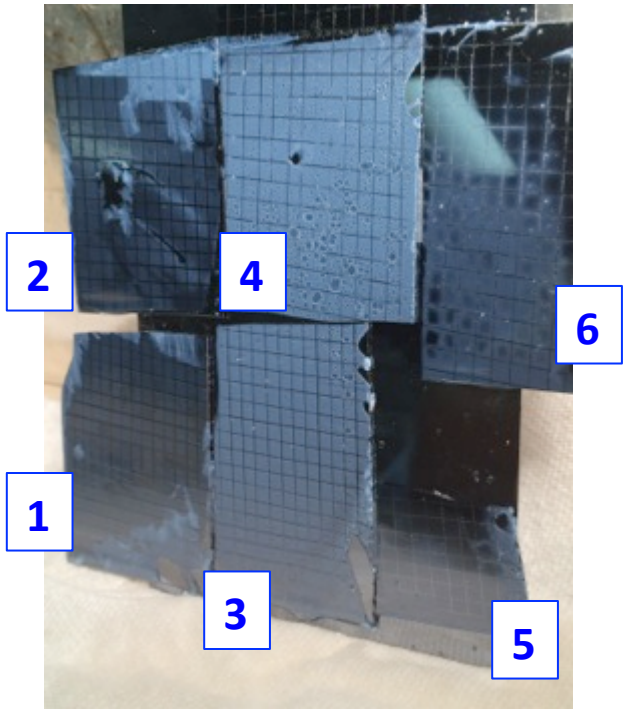
- **Model saw process:**
  - Coat and cut cross-hatch network into coating/ substrate;
  - Immerse to 50°C DIW with aggressive mixing;
  - Record observations over time.



Cross-hatch substrates immersed to a beaker, 50°C w/aggressive mixing

Saw Model: 50°C DIW @ 20min

Immersion



Observations

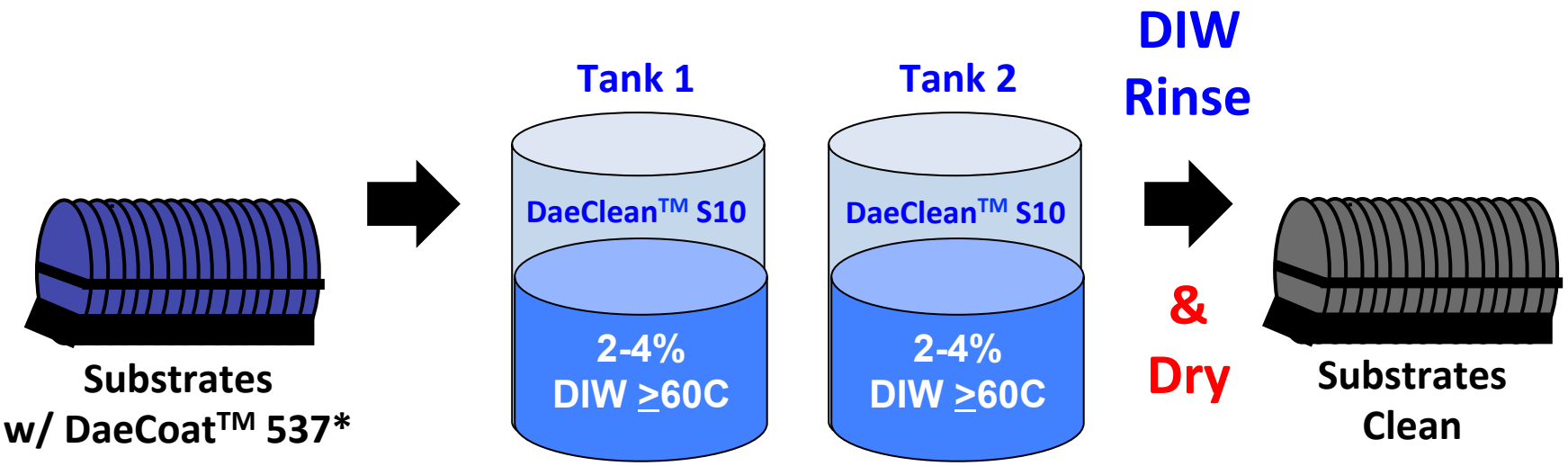
DaeCoat™ 537* (Hot Water Washing)

- DaeCoat™ 537* resists hot water (pure);
- Dissolves when using 2-4% DaeClean™ S10 surfactant, ≥60°C5min;
- Depending upon thickness, substrate, agitation, the cleans perform as follows:
  - 2% DaeClean™ S10 @ 80°C, ~5min;
  - 4% DaeClean™ S10 @ 60°C, ~5min;
- DIW rinse & dry.

*DaeCoat™ 537 = upgraded 535

DaeCoat™ 537* Cleaning

DaeClean™ S10 Surfactant

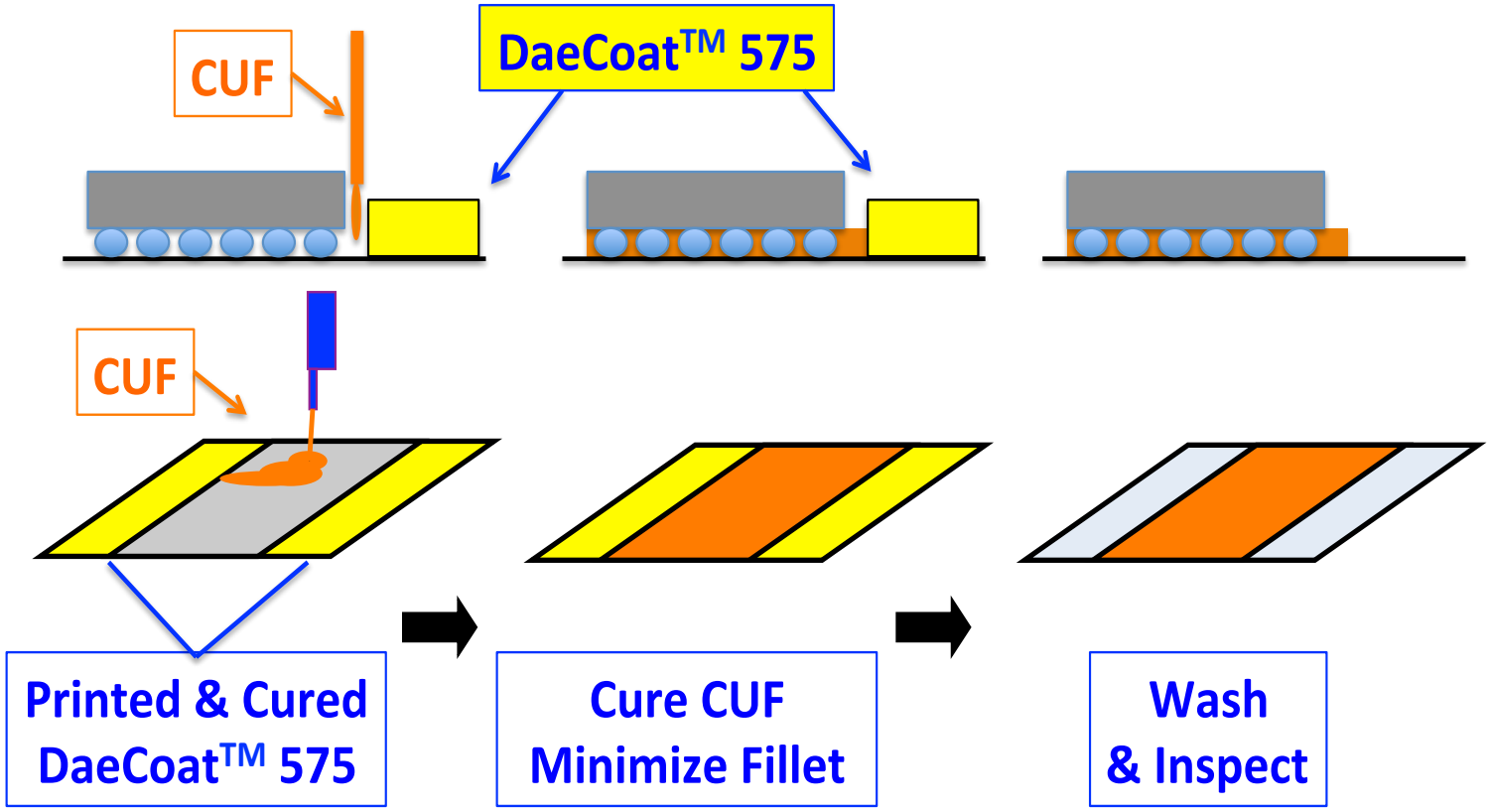


DaeClean™ S10 Surfactant
2-4% in DIW, ≥60C ~5min

2 Tanks + DIW rinse (RT)
Dirty + clean/rinse tank
Follow w/DIW (pure) Rinsing

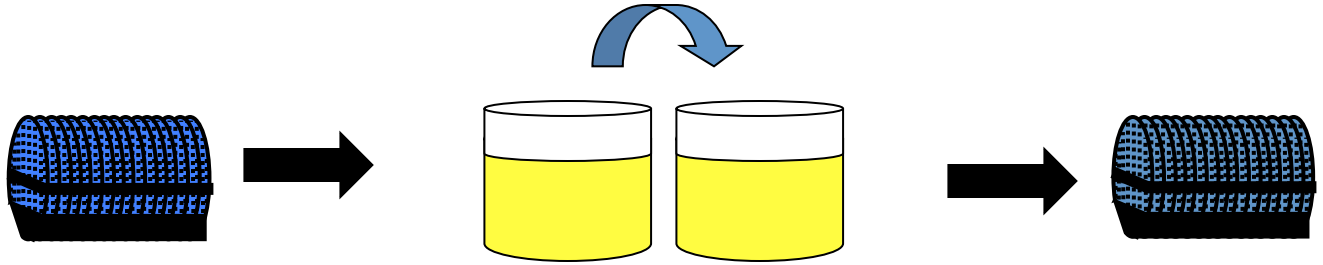
*DaeCoat™ 537 = upgraded 535

Other Washable Coatings



CoatsCleans™ vs. Immersion

Using Liquids (Solvents) to Clean Solids (Polymers)



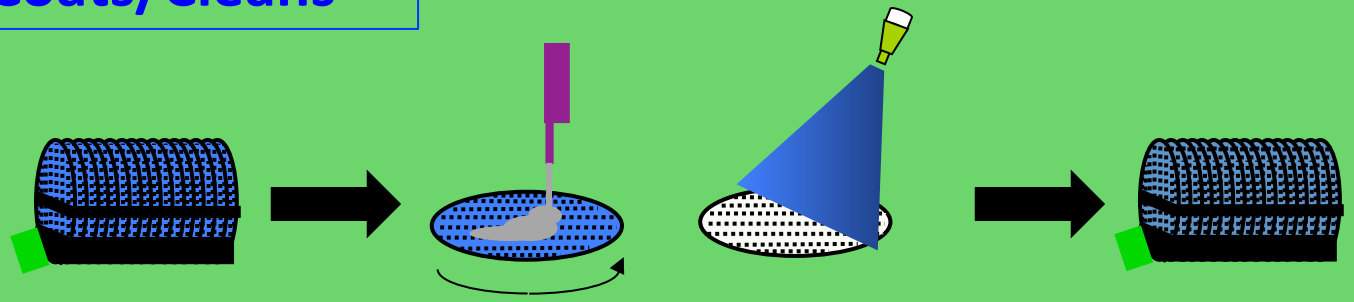
Treated Wafers

Solvent Immersion

- Long Time
- Ineffective
- Corrosion
- Solvent Intensive
- Hazardous

Coats/Cleans™

Using Solids (Polymers) to Clean Solids (Polymers)

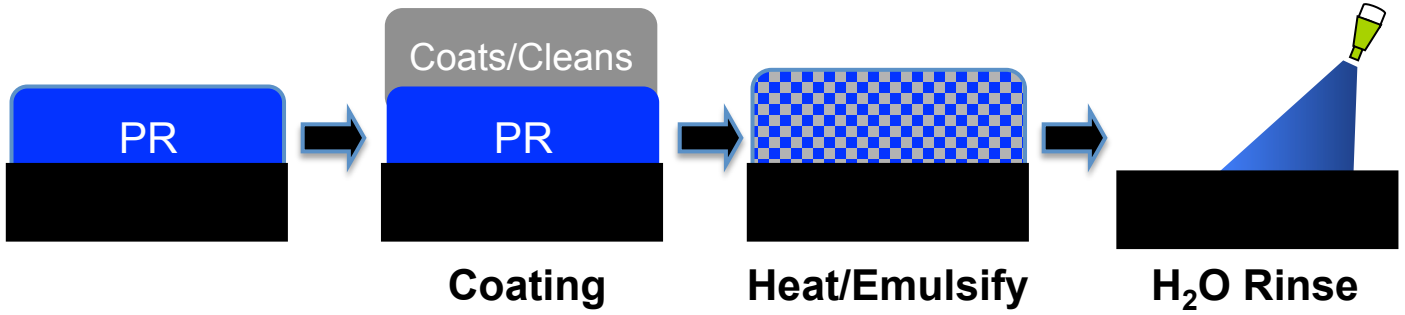


Treated Wafers

Coat & Water Wash

- Fast
- Multi-purpose
- Metal Safe
- Water Rinse
- EHS Approved

Stripping Neg-Acrylic PR (Bumping)



Wafer ID	Before – PR Present	After <15min Dissolve/Rinse
1 Pos - Liq Merck AZ P4620 50-60um		
2 Neg - Liq JSR THB-151N 20-24um		
3 Neg - Liq DOW BPR-100 50-60um		

Wafer ID	Before – PR Present	After <15min Dissolve/Rinse
4 Neg-DF DuPont WB100-series 100-120um		
5 Neg - DF TOK 100-120um		
6 Neg - DF Asahi Sunfort 100-125um		

Summary

- Washable coatings must meet the process needs and be robust for cleaning;
- Apply to temporary bonding, planarization, sawing, laser processing, and patterning;
- DaeCoat™ products are used in many processes for packaging and thin substrate handling.

Special Thanks to…

- Fraunhofer IZM
  - Kai Zoschke, Matthias Wegner
- DPSS Lasers, Inc.
  - Alex Laymon
- Daetec
  - Jared Pettit, Alman Law

Contact for more information

- DAETEC provides development, consulting, and technical training/support to solve manufacturing problems and introduce new options of doing business.
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