

# Washable Coatings for Packaging Practices

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IMAPS Device Packaging Conference  
March 2016



# Contents

- Washable Coating Defined
- Equipment
- Applications
- Summary



# Washable Coating Defined

- Includes protective coating & adhesive
- Performs work function
- Removes without substrate compromise
- Washing includes water, detergent or non-hazardous solvents
- Washing conditions extremely mild, safe for common film frame tapes
- Match washable coating to process conditions

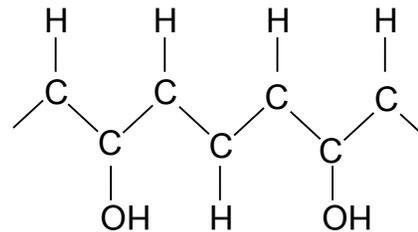


# Aqueous Washable Polymers

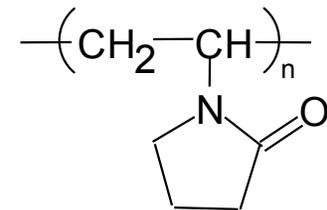
## PVA & PVP - Benefits

- Barrier
- Film Forming
- DIW Soluble

## PVA

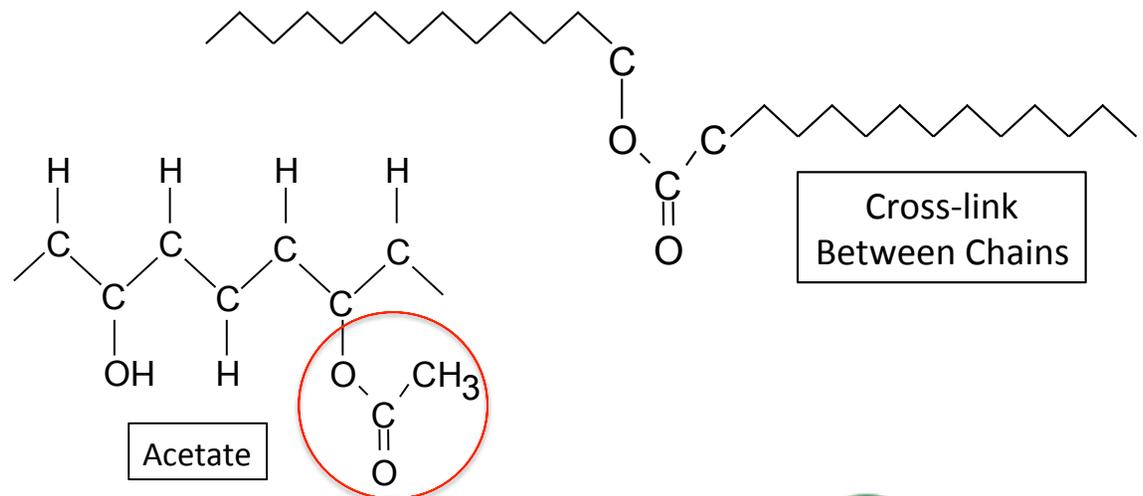


## PVP



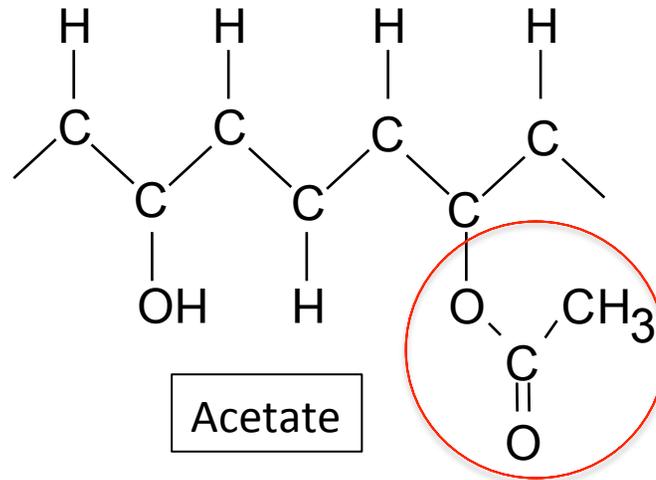
## Drawbacks

- Low temp resistance
- Cross-linking
- Loss of solubility

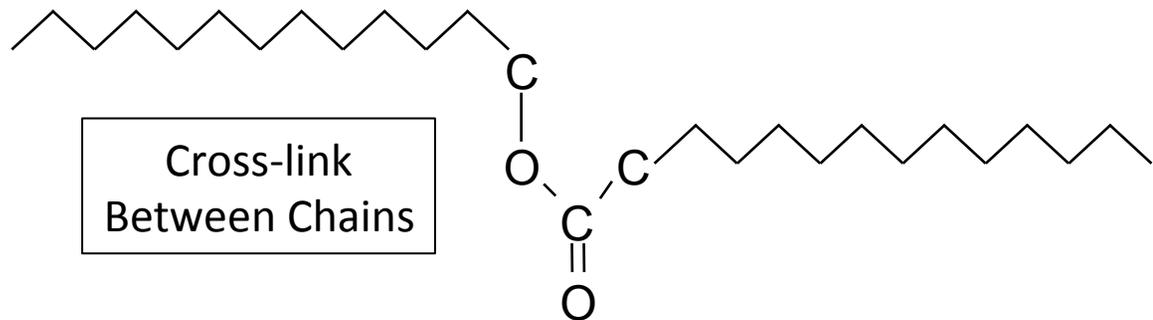


# Degree of Cross-linking vs. Cleans

- Highly Cross-linked materials require more aggressive means of washing



Long chain molecules exist as random intermingled mixtures with a tendency towards cross-linking



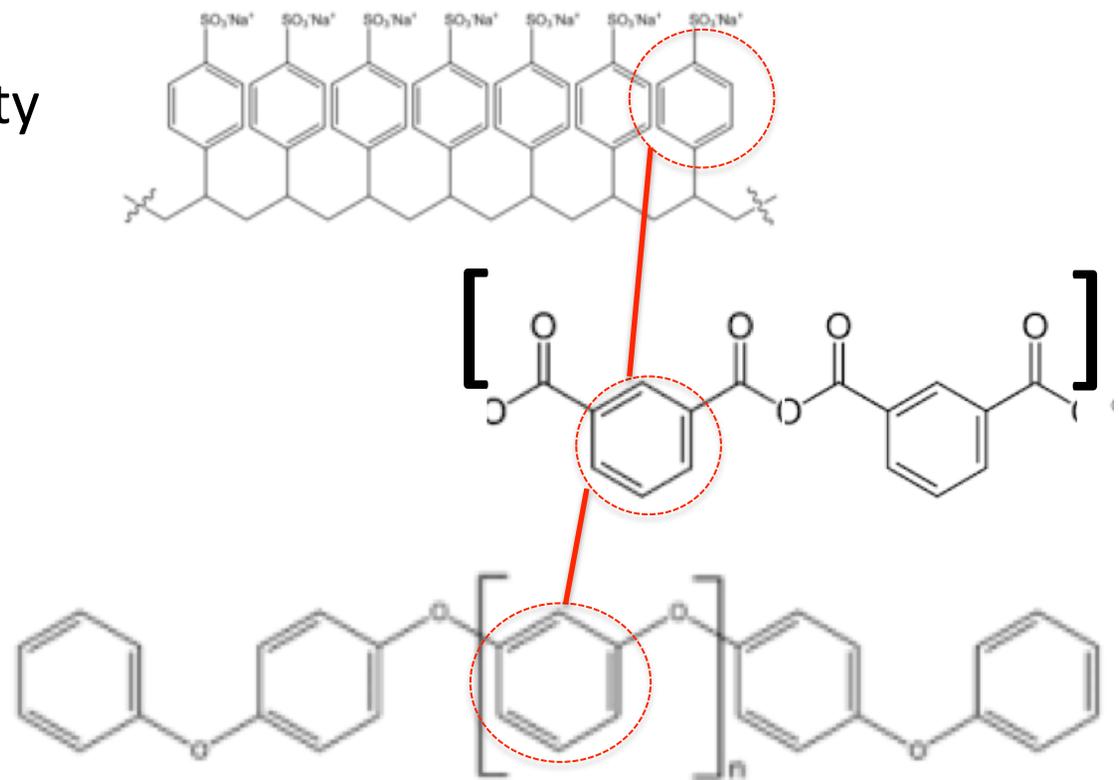
# Improved Thermal Resistance

## Thermal Resistance

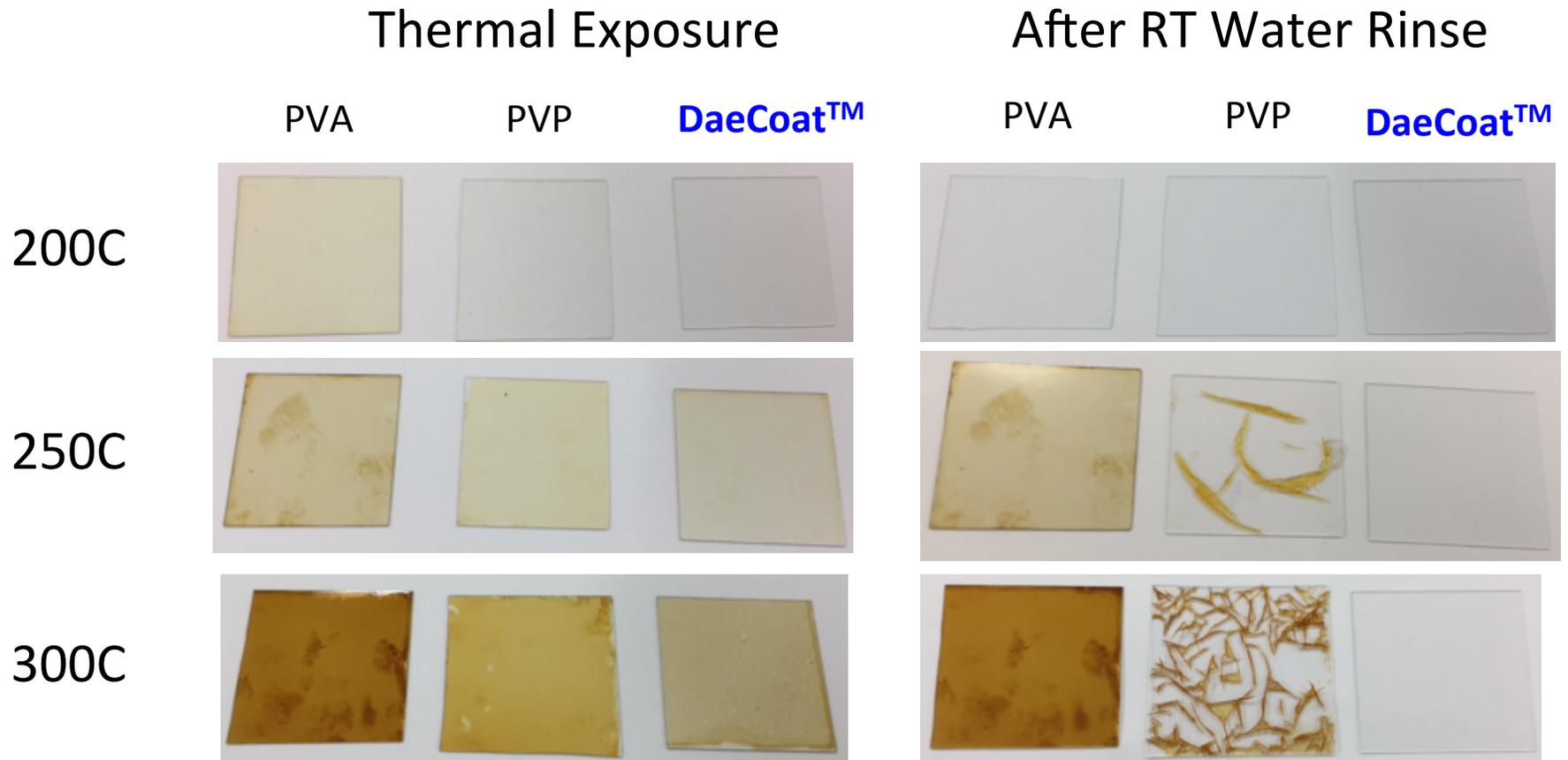
- Chemical functionality
  - Phenyl
  - Polyester

## DaeCoat™ Systems

- Phenyl silicones
- Polyphenylsulfones
- Salt conjugates

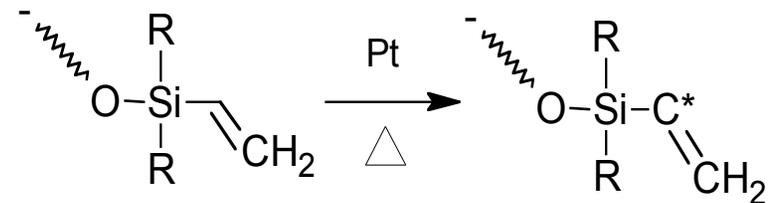


# Thermal Resistant Washable Coatings



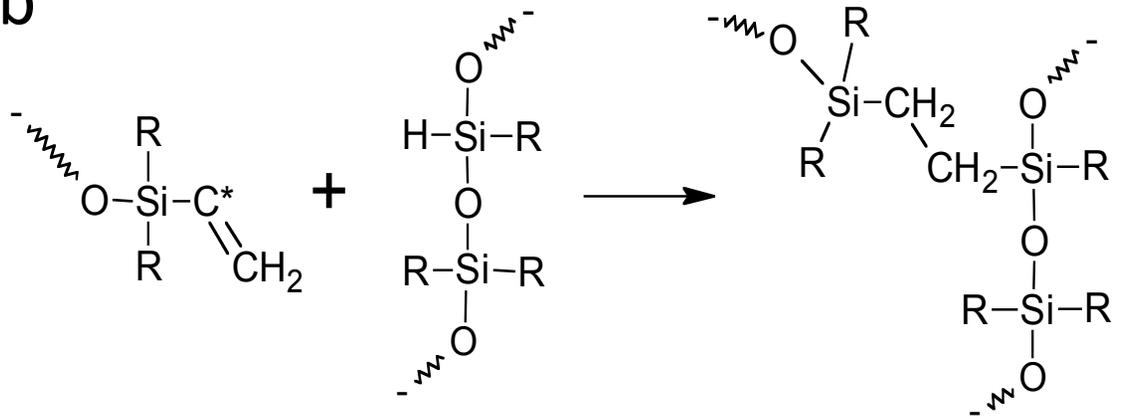
# Washable Polymers - Solvent

- Good Thermal resistant
- Excellent Coating Qualities
- High Resistance to Fab Process Chemicals
- Formulate to allow easy rinseability after high temp processing



**Resin monomer**  
(MW & shape)

**Free-Radical**



**Activator monomer**  
(MW & shape)

**Silicone Polymer**



# Silicone Chemical Resistance

Chemical Exposure (@ 25°C)	Time (min)	Effects
NMP	30	No Attack
Acetone	30	No Attack
TMAH (2.38%)	30	No Attack
KOH (1%)	30	No Attack
CH <sub>3</sub> COOH (9-10%)	30	No Attack
H <sub>3</sub> PO <sub>4</sub> (68-69%)	30	No Attack
HNO <sub>3</sub> (4~5%)	30	No Attack
H <sub>4</sub> C <sub>2</sub> O <sub>4</sub>	30	No Attack
PGMEA	30	No Attack
MEA	30	No Attack
DMSO	30	No Attack



# Desired Properties

Property	Protective Coating	Temporary Bond
Simple application (spin, spray)	X	X
Simple curing (<15min)	X	X
Able to planarize large features	X	X
Thermal Resistant (>300C)	X	X
Low outgas for vacuum processing	X	X
Resist fab process chemicals	X	X
Mechanical integrity for grind/polish	N/A	X
Simple debond & cleans (porous support)	N/A	X
May use different carriers	N/A	X

# Equipment

- Spin
- Slit
- Spray
- Film



# Wafer Grinding & Testing

- Use a local grind/polish firm (Arizona, USA)
- Equipment is consistent with that used in fabs
- Scientists have a high degree of experience



Strausbaugh



Process

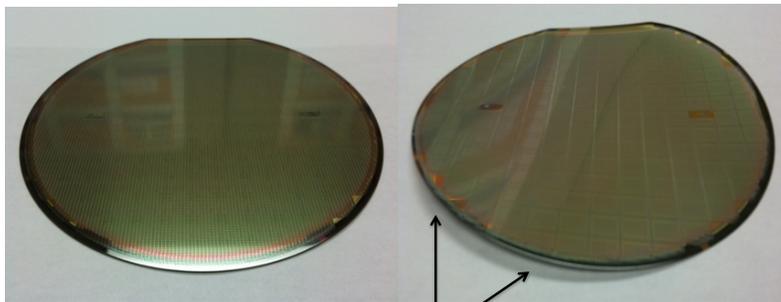
# Laser Scribing



- Small Spot Sizes
- Cold UV Marking
- Easy To Use Software
- Fast Scanning Speeds
- Integrated UV Marking Solution
- < 700 Watt Single Phase Utility Required
- Field Proven Model 3500 Series 355 nm Laser
- Materials Can Be Marked, Engraved, Scribed, Cut Or Drilled

# Substrate Types

- Rigid: silicon, quartz, glass, sapphire
- Flexible: PI, PEN, Arylite, PPS, PET, epoxy
- Ideal characteristics: CTE match, low TTV
- Other qualities: transparency, tensile, barrier
- Dimensions: application specific

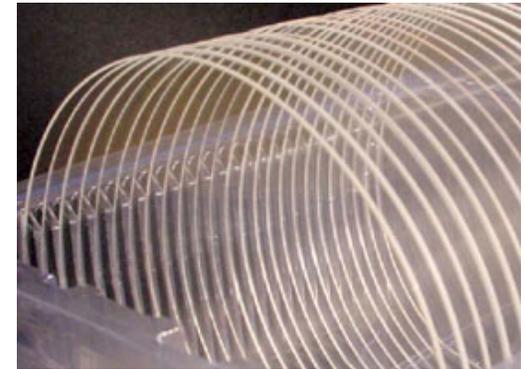
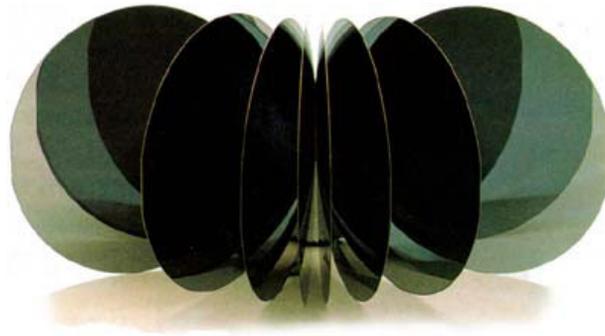


Wafer Bow



# Solid Carriers

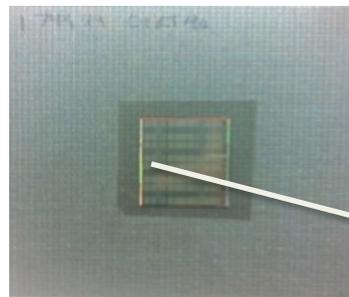
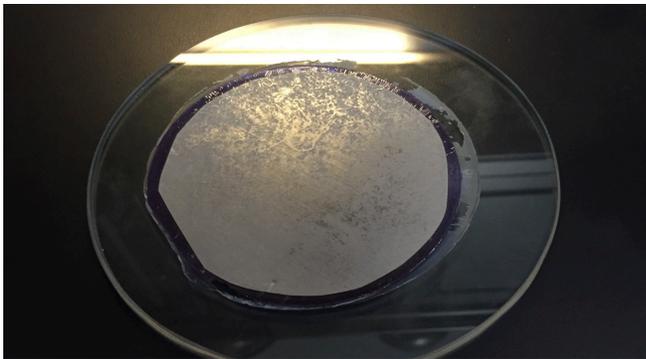
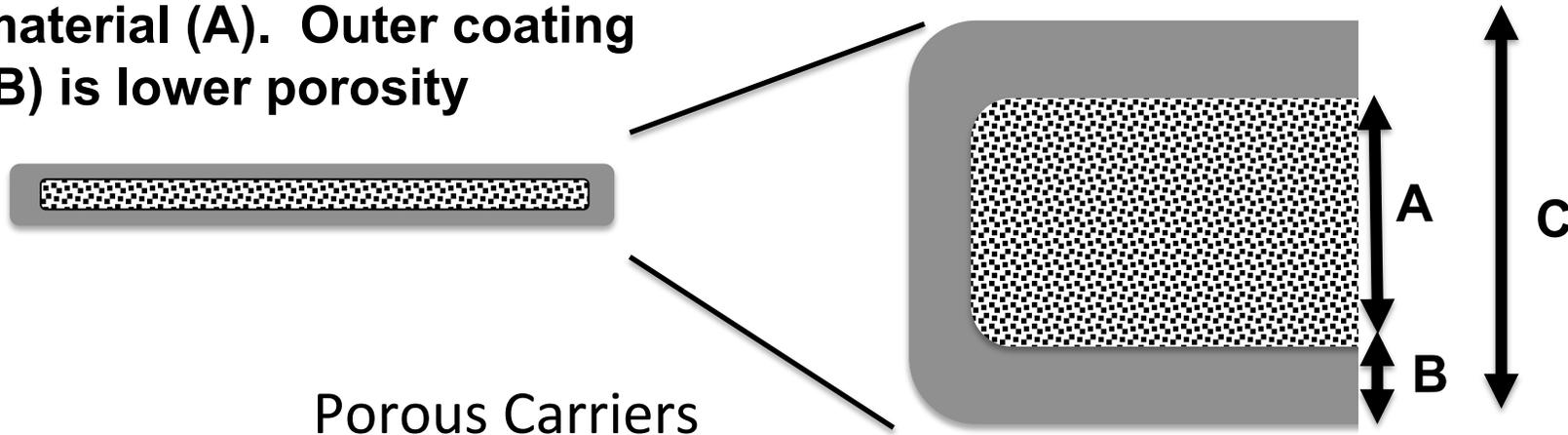
- Silicon
- Glass
- Sapphire
- Tape



# Porous Carriers

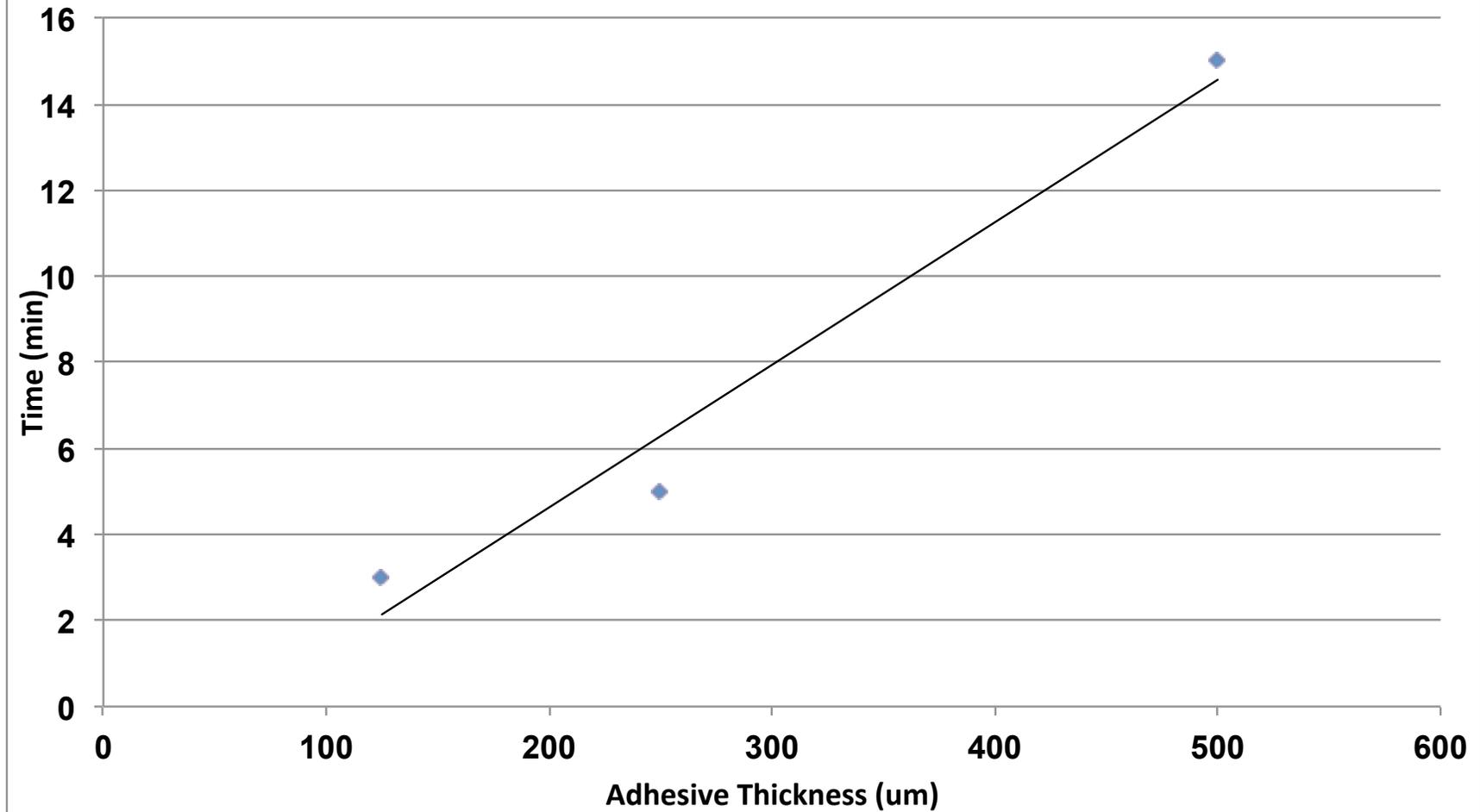
- SUS304, Titanium, Ceramic film

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



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

## Adhesive Removal Time vs. Thickness



# Experimental

1. Wafer Thinning – green solvent wash
2. LTCC – DIW wash
3. Wafer Planarization – green solvent wash
4. Wafer Thinning – detergent wash
5. Laser Processing – DIW wash



# #1: Wafer Thinning

## Process Demand

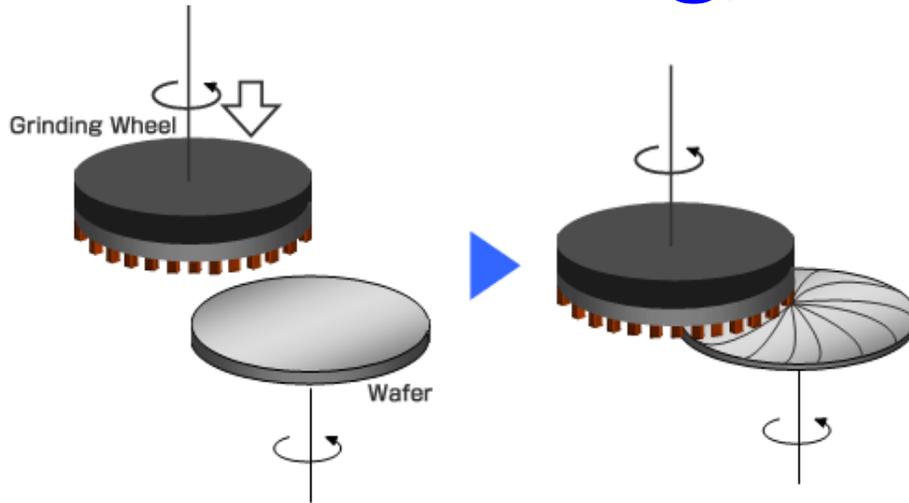
- **Objective:** Wafer thinning, backside processing
- **Mechanical (e.g. grind):** Yes
- **Thermal resistance:** <300C
- **Process/chemicals:** Yes
- **Uniformity:** ~2um

## 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

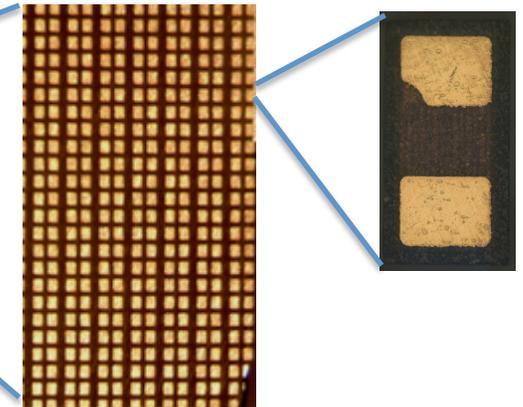
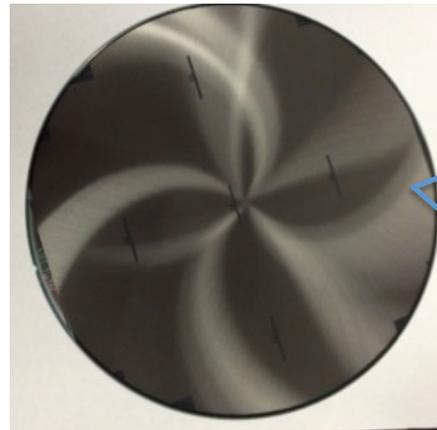


# #1 – Thinning, Processing, Release



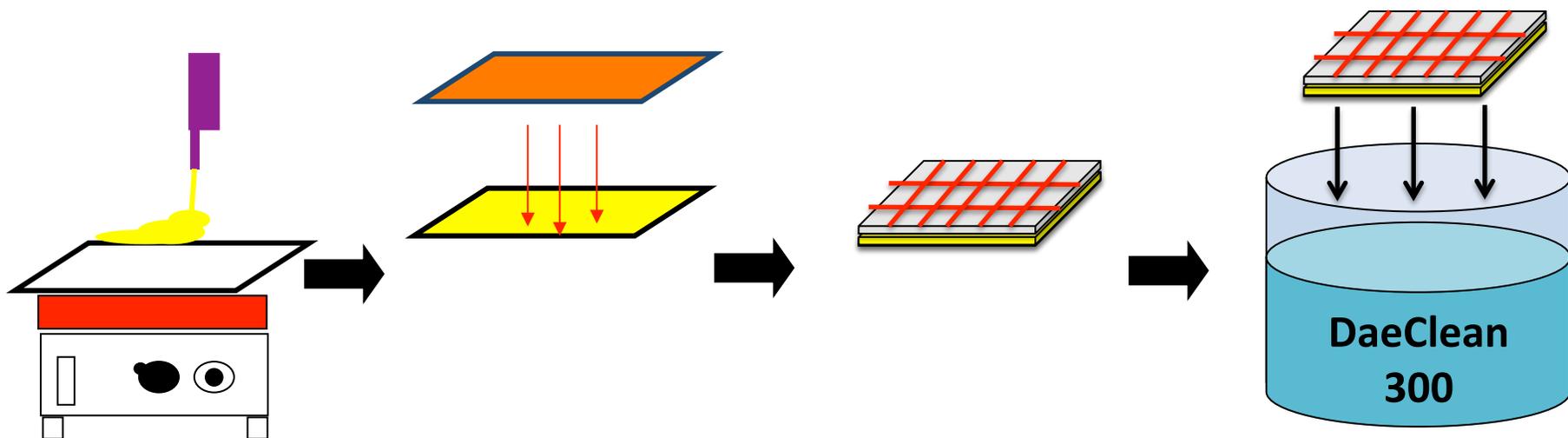
Grinding, backside processing, singulation

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



# Green Solvent Wash Adhesive

**Products:** DaeCoat™ 355 (dry bond adhesive) + DaeClean™ 300 (solvent cleans)



## Coating and Cure

Spin 20 um,  
Cure 150 C  
5 min

## Bond

\_Room Temp,  
<5min, ≥10 PSI  
Vacuum

## Customer Process

Sputter Metal  
Backside Grind to  
250um  
Dice Wafer

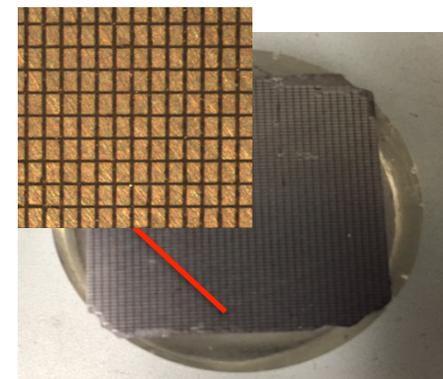
## Immersion Debond

25C Metal Safe  
Solvent  
Device Capture

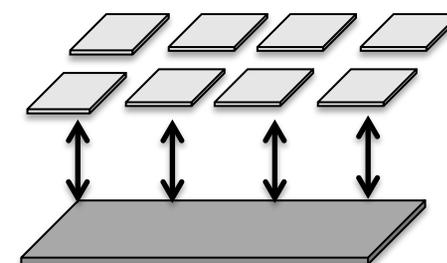


# Green Solvent Wash Adhesive

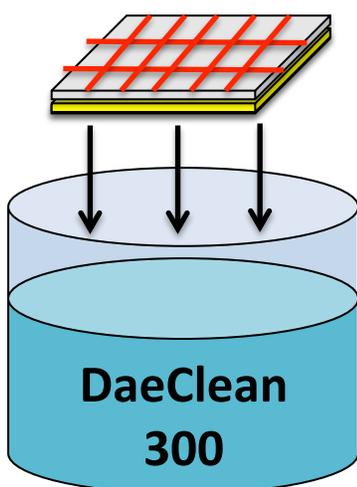
## Debond Process: Dice and Chemical Debond



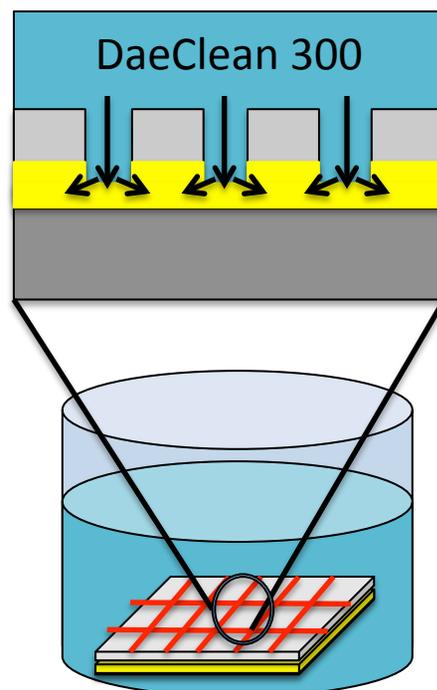
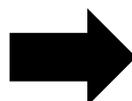
**Device:**  
Capture/Further Processing



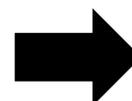
**Carrier:**  
Release and Recycle



**Immerse**  
**Diced Wafer**



**DaeClean 300 Penetrates and**  
**Dissolves DaeCoat 355 Adhesive**



# #2: Low Temp Co-fired Ceramic

## Process Demand

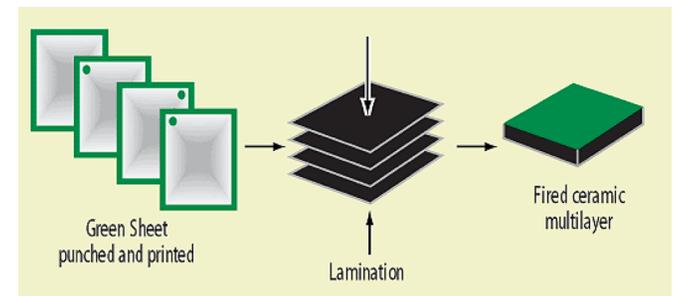
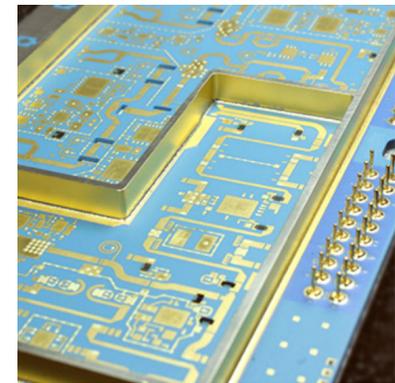
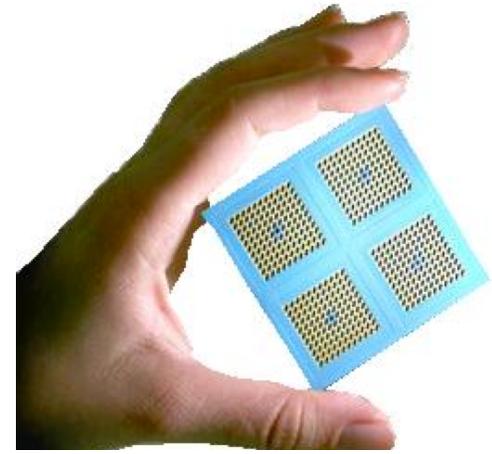
- **Objective:** LTCC flip-chip bond & encapsulate
- **Mechanical (e.g. grind):** No
- **Thermal resistance:** ~275C
- **Process/chemicals:** limited, RT flux cleaner
- **Uniformity:** <10%

## Recommendation

- **DaeCoat™ 535**
  - Hot DIW washable
  - RT chemical resistance
  - Thermal resistance: >300C
- **Carrier:** Porous
  - chemical diffusion
  - recycled

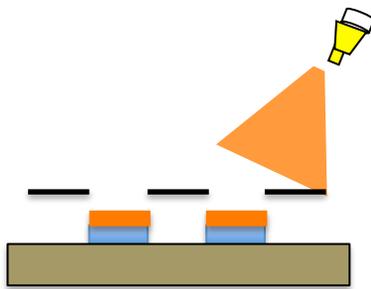
# LTCC/HTCC

- Microelectronics on a ceramic substrate
- Multi-layer packaging
- MEMS, military, RF, wireless
- Thickness <math><50\mu\text{m}</math> to <math>>250\mu\text{m}</math>
- Commonly 100-150 $\mu\text{m}$
- Green tape – several suppliers
- Extremely fragile – handling challenge!



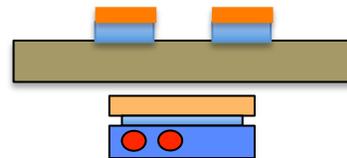
# DIW Wash Adhesive (LTCC)

**Products:** DaeCoat™ 535 (hot DIW washable)



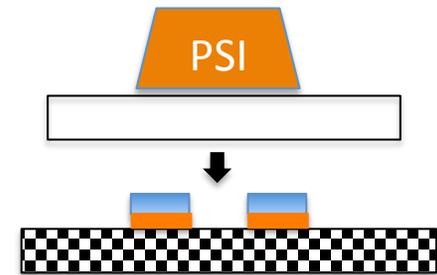
**Coating**

- Spray Adhesive onto Device



**Heat Cure**

- 5 min, 100 C
- 5 min, 150 C

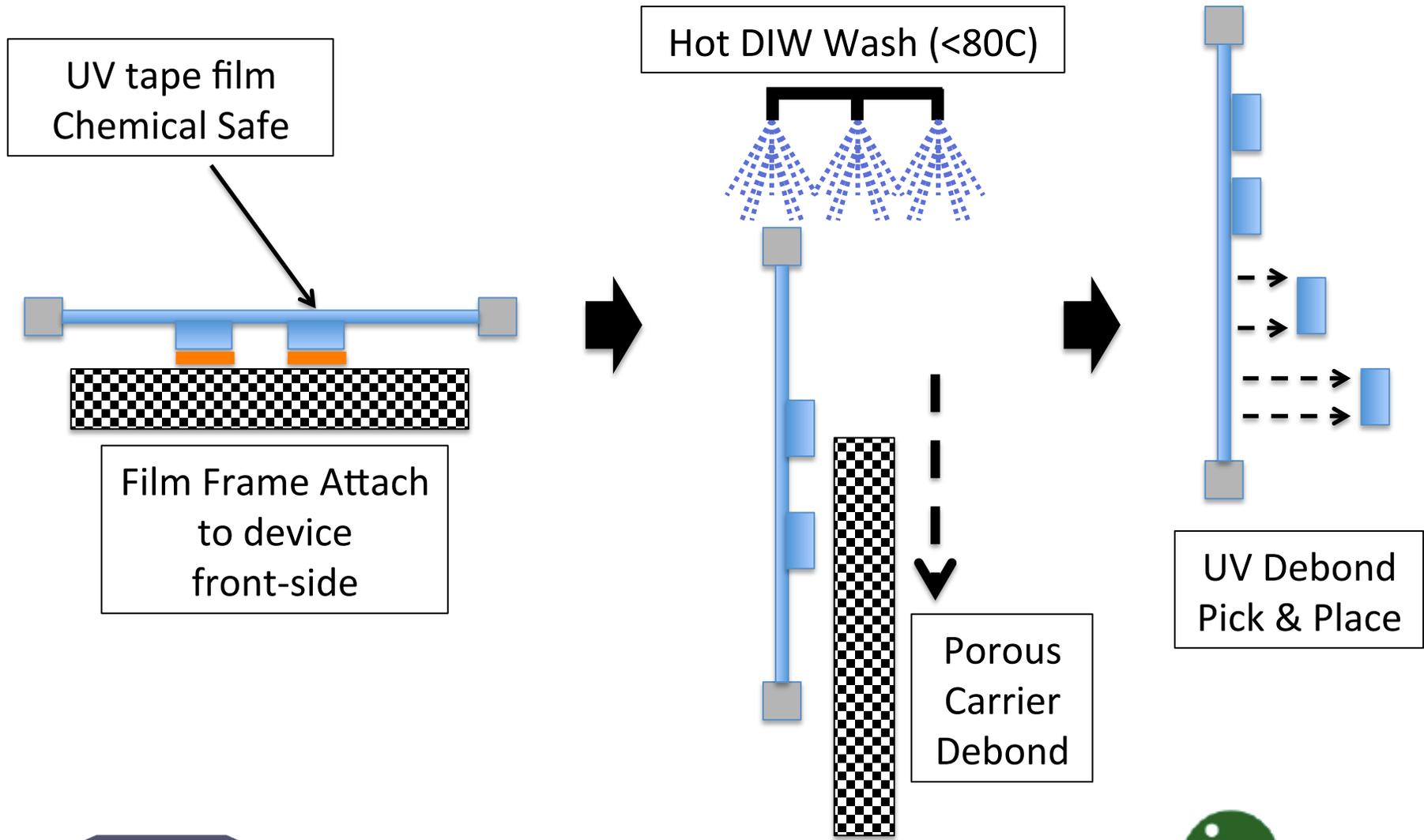


**Bonding to Porous Carrier w/Pressure**

- 5 min, 160-180C
- 1-5 PSI



# DIW Wash Adhesive (LTCC)



# #3: Wafer Planarization

## Process Demand

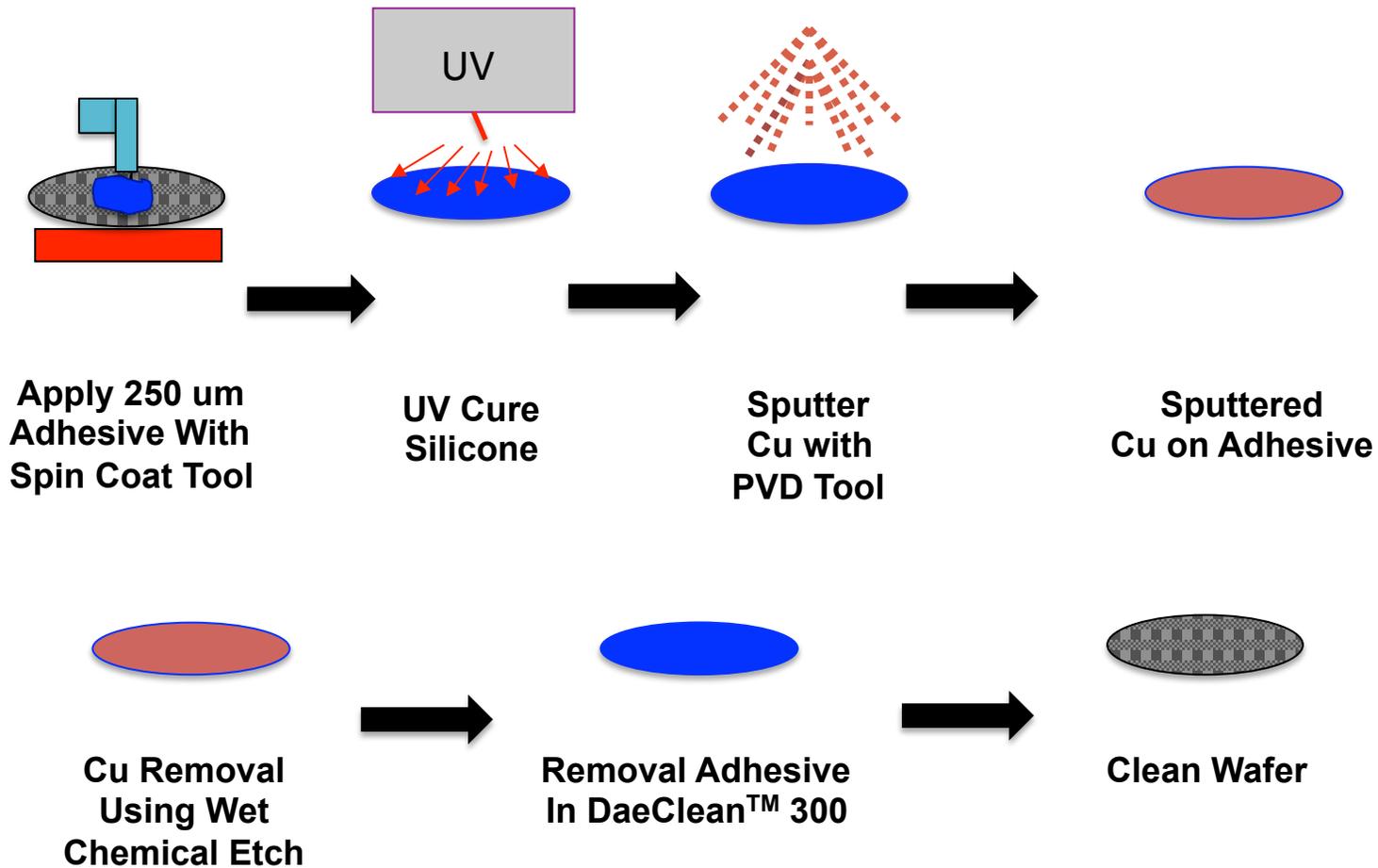
- **Objective:** Wafer planarizing coating for backside processing
- **Mechanical (e.g. grind):** No
- **Thermal resistance:** <300C
- **Process/chemicals:** Yes
- **Uniformity:** <5%
- **Special:** Desire to finish on FF tape

## Recommendation

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



# Washable Planarization Coating

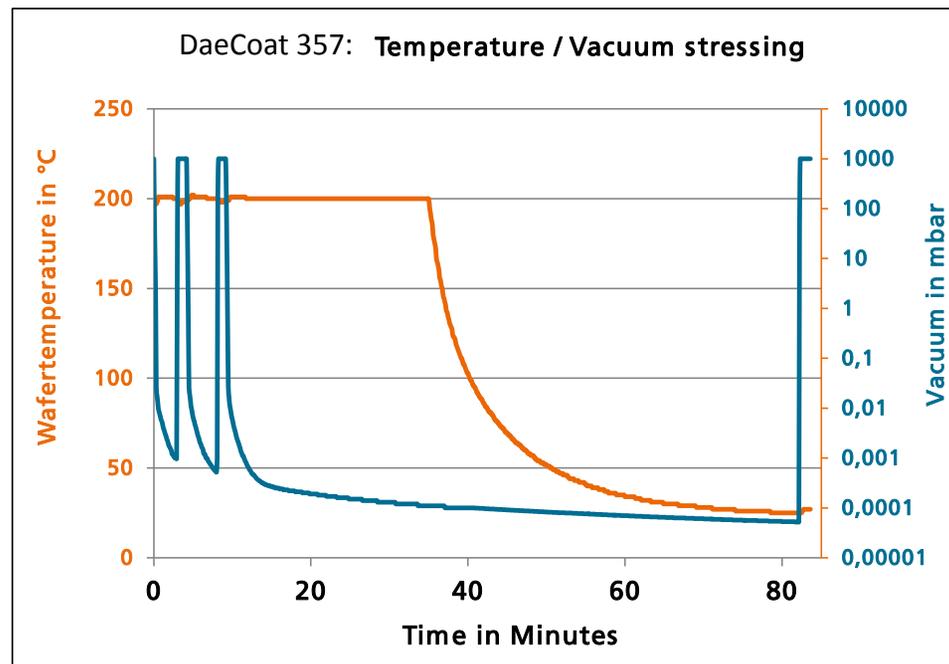


# Washable Planarization Coating

**Products:** DaeCoat™ 357 (UV curable silicone)

**Temperature / Vacuum stressing**

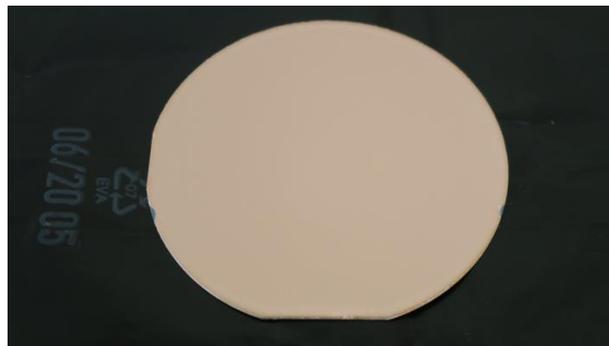
- No outgassing of the 250 um DaeCoat 357 coating layer during 40min exposure to 200°C at high vacuum.
- This test was done to test if coating can survive typical PVD and PECVD process conditions.



# Washable Planarization Coating

## Sputtering Test

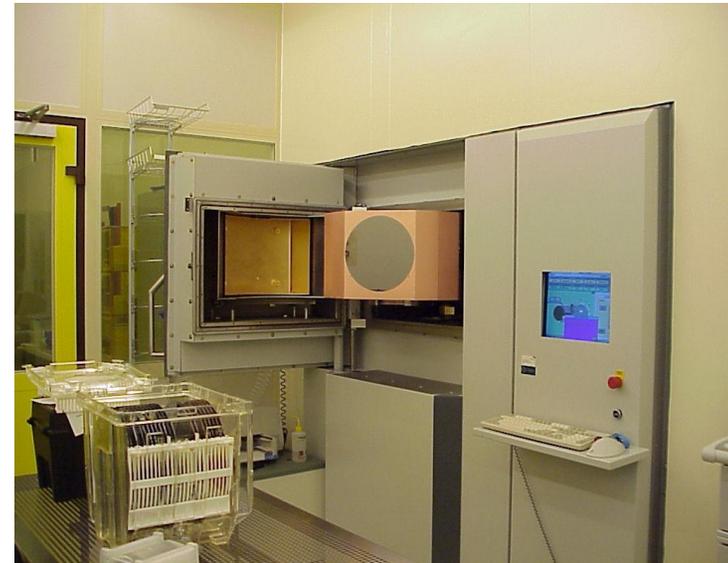
- Sputter deposition of 200nm Ti:W + 300nm Copper on 250µm thick DaeCoat 357 using LLS802 multi target tool



wafer with 100:1  
mix ratio after  
sputtering



wafer with 50:1  
mix ratio after  
sputtering

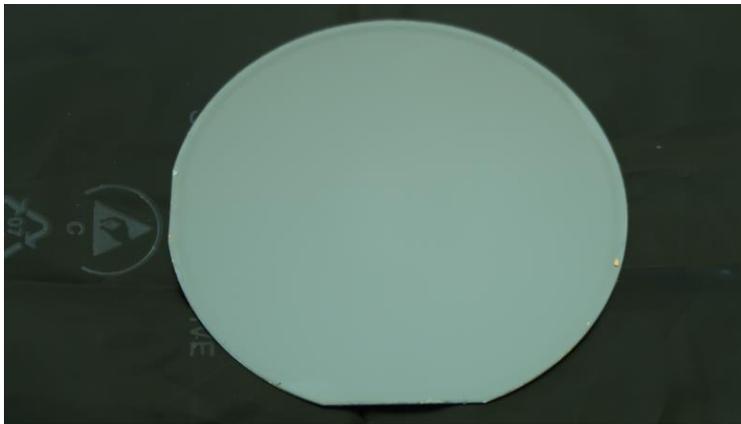


Chamber Capability:  
24 x 4" - 6" wafers per batch  
8 x 8" wafers per batch  
4 x 300 mm wafers per batch

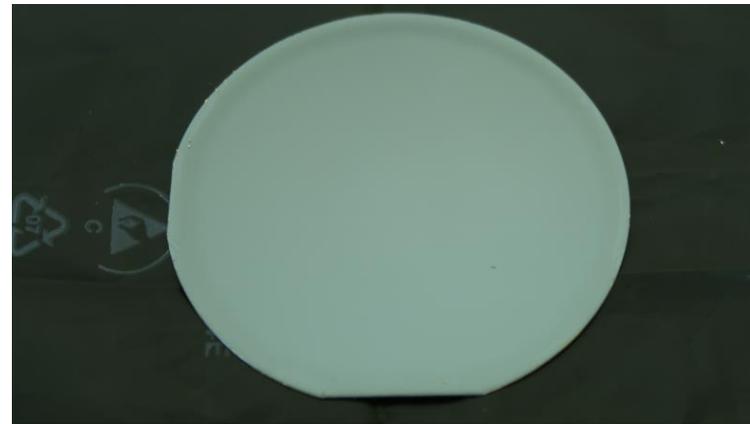
# Washable Planarization Coating

## Etching Test

- Removal of 300 nm Copper + 200 nm Ti:W from 250 um thick DaeCoat 357 by wet chemical etching



wafer with 100:1 mix ratio after wet chemical etching



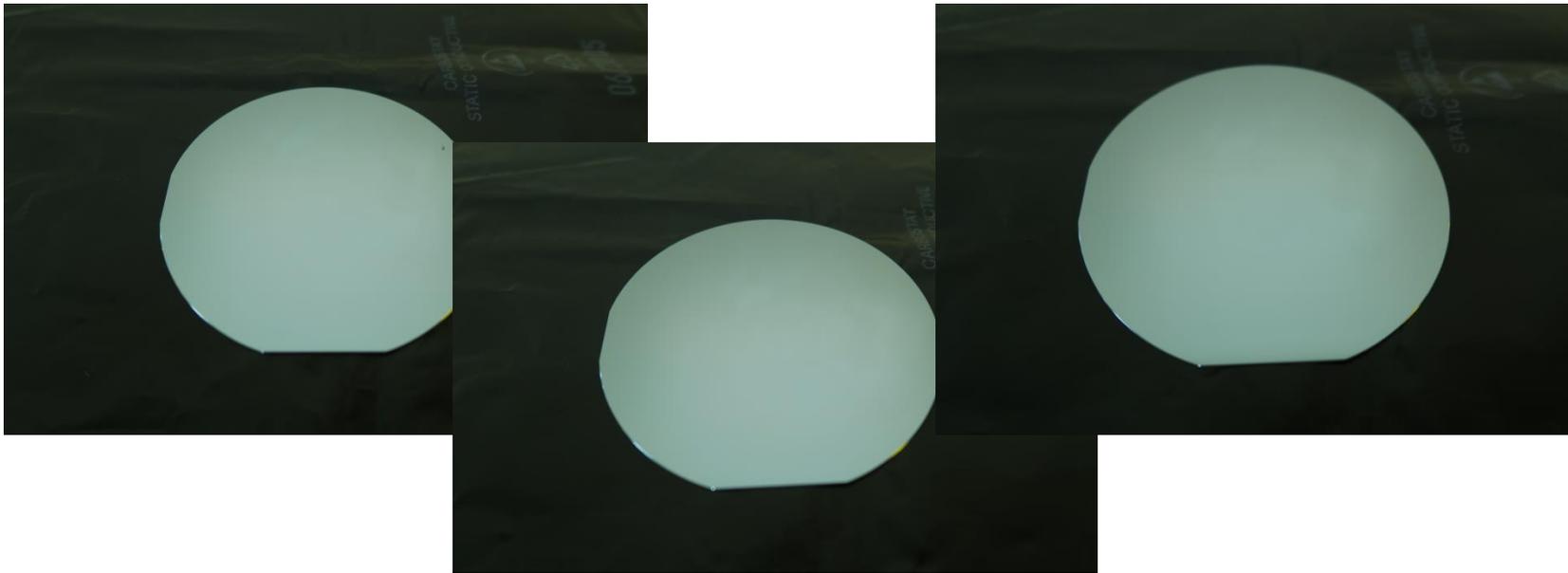
wafer with 50:1 mix ratio after wet chemical etching

# Washable Planarization Coating

## Cleaning Test

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- Removal of 250 um thick DaeCoat 357 by DaeClean 300



# #4: Wafer Thinning

## Process Demand

- **Objective:** Wafer grind & backside processing
- **Mechanical (e.g. grind):** Yes
- **Thermal resistance:** <200C
- **Process/chemicals:** Yes
- **Uniformity:** ~2um

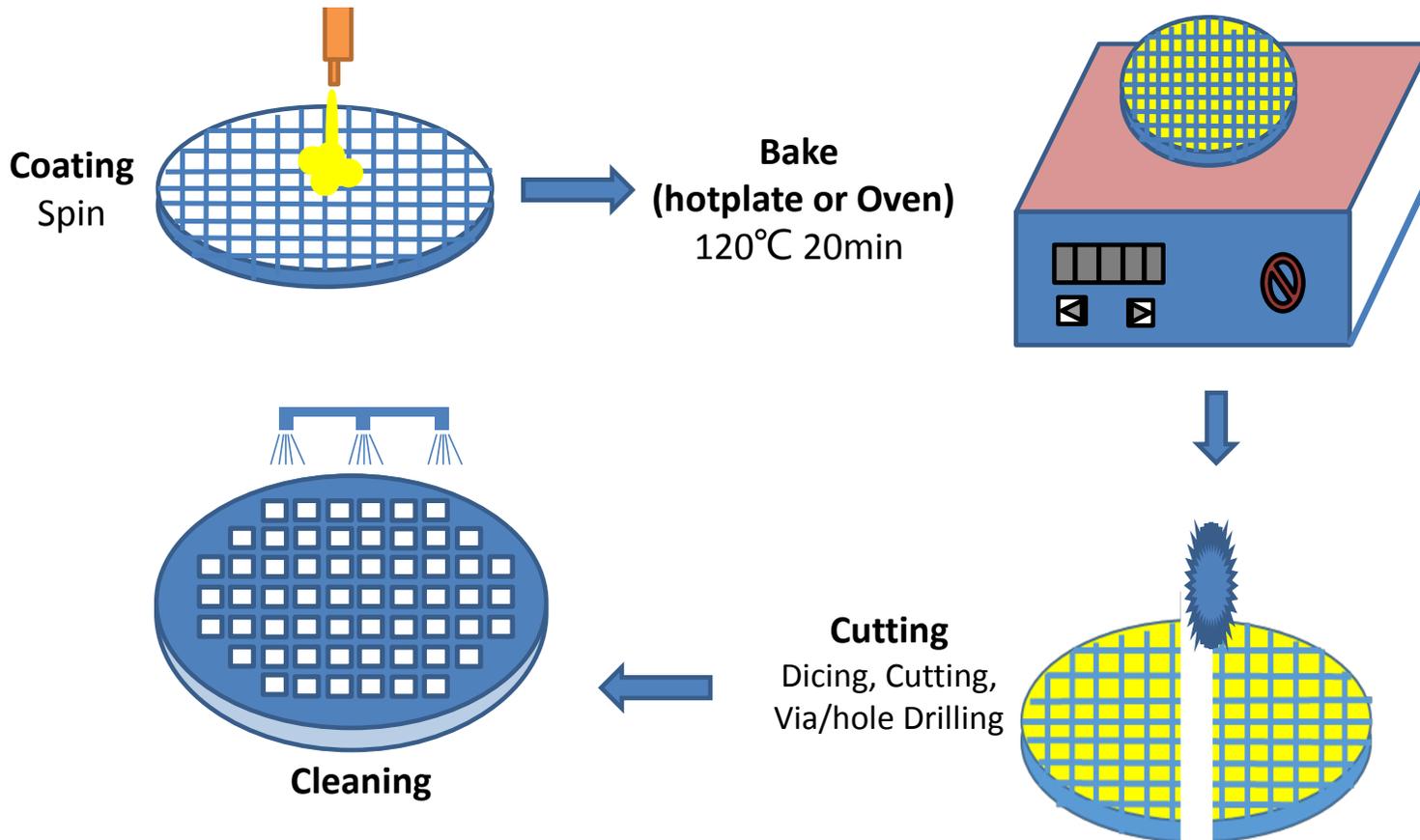
## Recommendation

- **DaeCoat™ 615**
  - Detergent washable, DaeClean™ 150
  - process chemical resistance
  - Thermal resistance: >200C
- **Carrier:** Solid or porous; may thermal release or use FF tape support

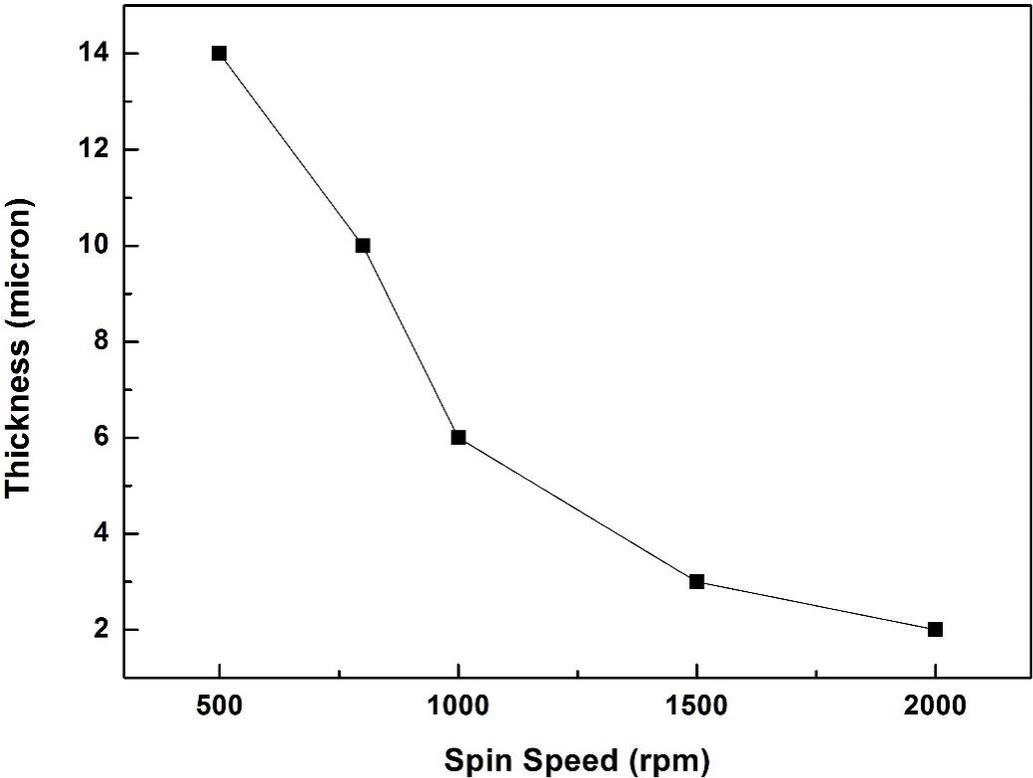


# Detergent Washable System

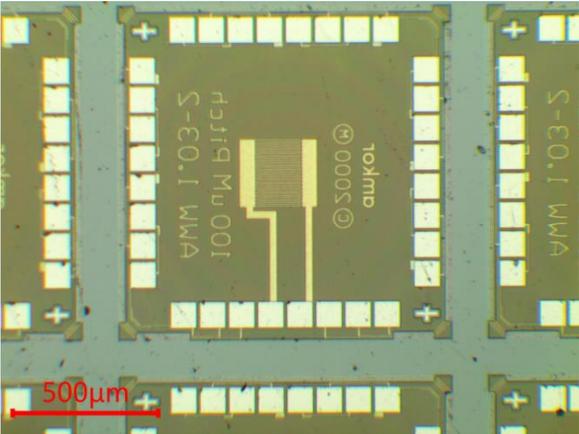
Products: DaeCoat™ 615



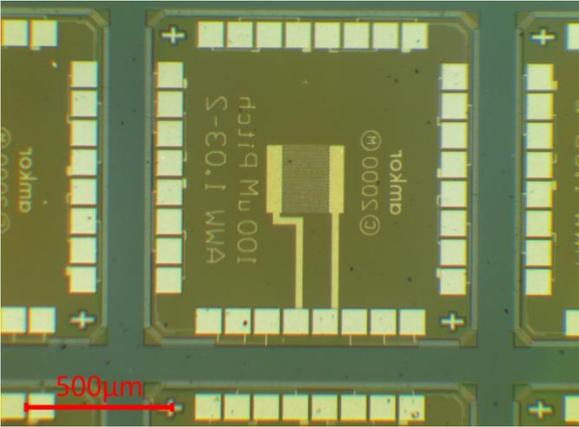
# Detergent Washable System



Spin Speed Curve of DaeCoat 615



Function Wafer w/o DaeCoat 615

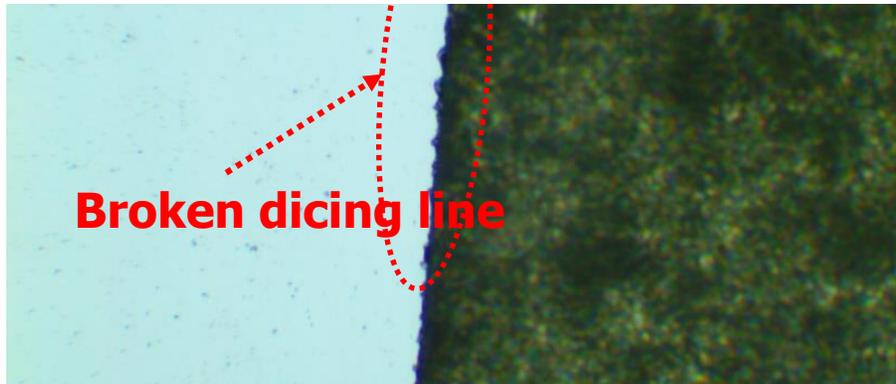


Function Wafer w/ DaeCoat 615

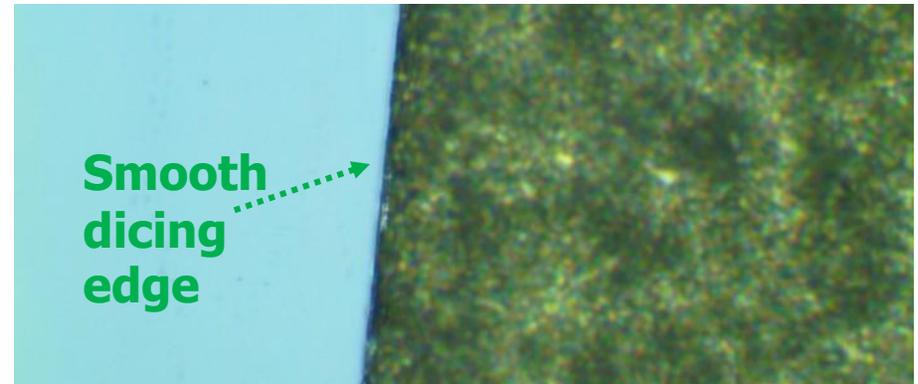


# Detergent Washable System

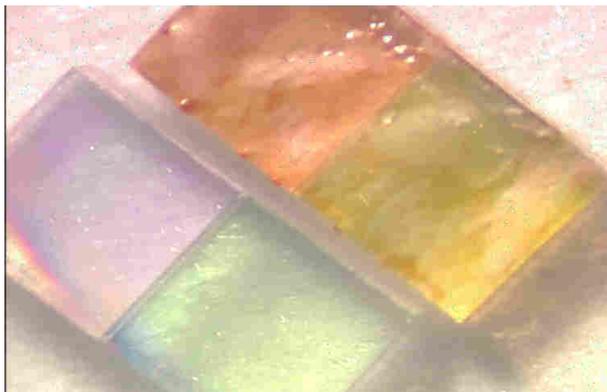
No coating



With DaeCoat 615



Before Cleans



After Detergent Cleans



# #5: Laser Protective Coating

## Process Demand

- **Objective:** Laser scribe
- **Mechanical (e.g. grind):** No
- **Thermal resistance:** N/A
- **Process/chemicals:** No
- **Uniformity:** <1%

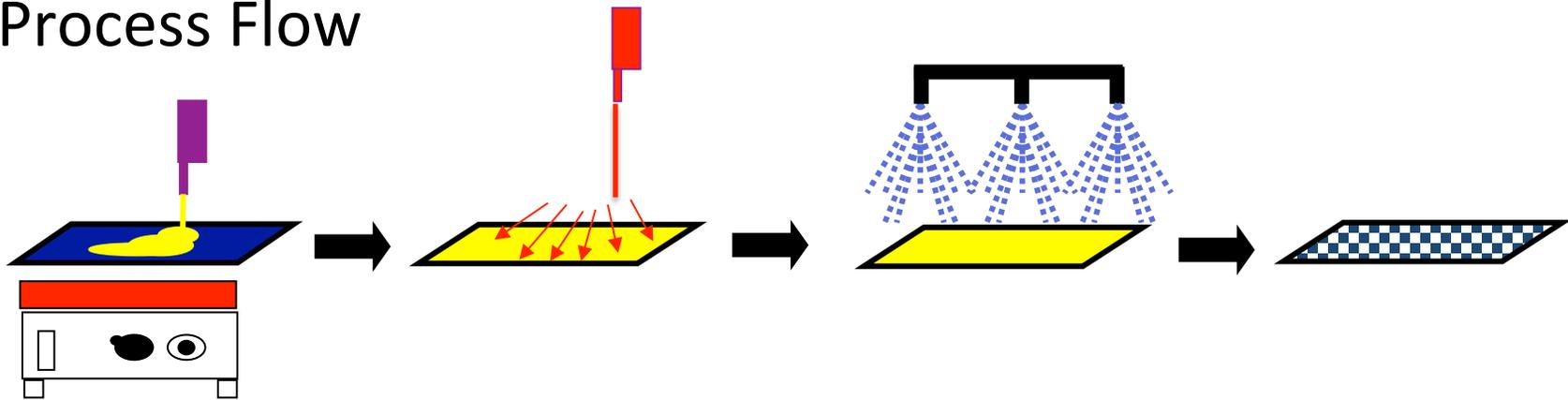
## Recommendation

- **DaeCoat™ 515**
  - DIW washable
  - Thermal resistance: >300C
- **Carrier:** N/A



# Washable Coating for Laser

## Process Flow



### Coating and Cure

Spin 20  $\mu\text{m}$ ,  
Cure 150 C  
5 min

### Laser Process

355 nm Laser  
@ 30 KHz @ 25nSec  
(100  $\mu\text{J}$  per pulse)

### DIW Wash

RT 1 min

### Scribed Substrate

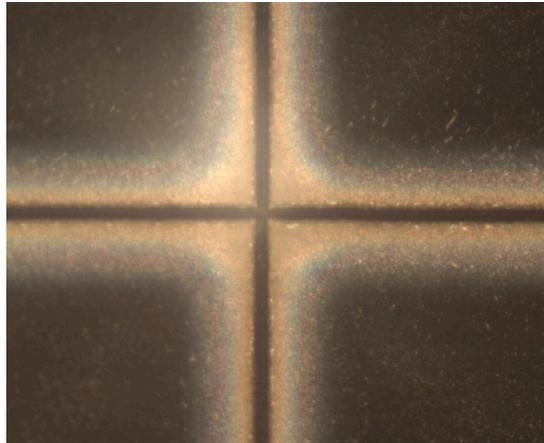
RT 1 min



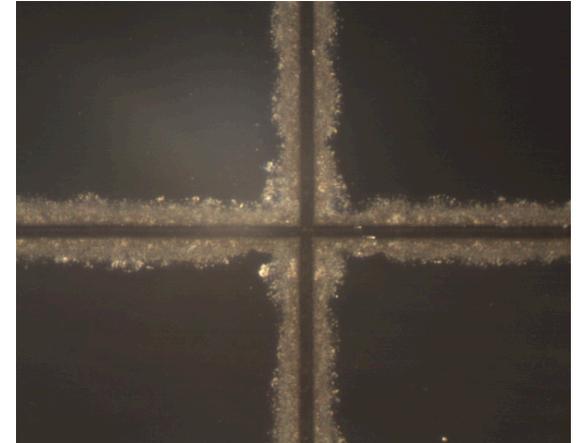
# Washable Coating for Laser

- Scribe on Silicon
- 20 um line width
- 25 passes
- Pictures taken after Laser Scribe process, DIW rinse

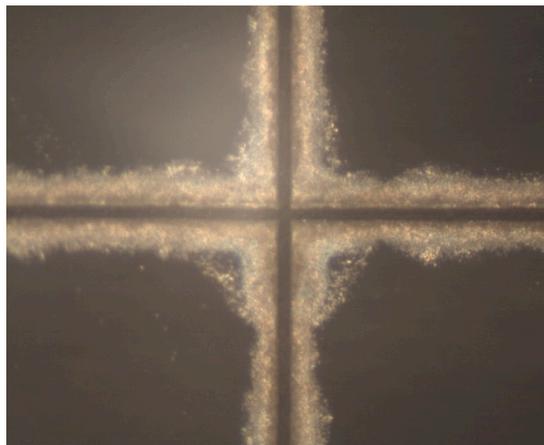
No Protective Layer



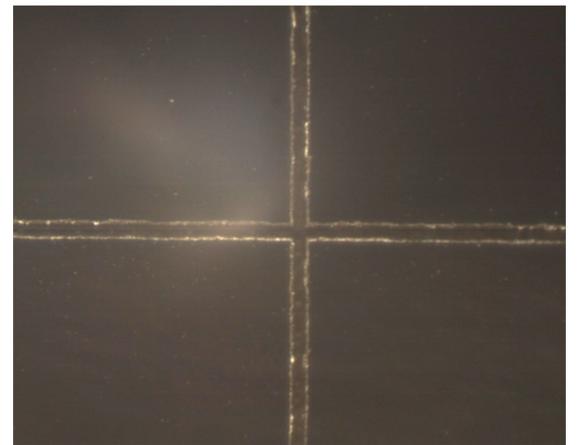
PVA Based Laser Coat



PVP Based Laser Coat



DaeCoat 515 Laser Coat



Parameter	DaeCoat™ 355	DaeCoat™ 357	DaeCoat™ 515	DaeCoat™ 535	DaeCoat™ 615
Coating Thickness	<5-100 um	<5-250 um	<5-100 um	<5-60 um	<5-60 um
Cure	UV/Thermal	UV/Thermal	Thermal	Thermal	Thermal
Max temp	~300C	~300C	~300C	~300C	~200C
Application	Temp Bonding or Coating	Temp Planarizing Coating	Laser Processing	Temp Bonding or Coating	Temp Bonding or Coating
Resists RT DIW*	✓	✓	✗	✓	✓
Resists Acids*	✓	✓	✗	✗	✓
Resists Litho Stripper Chemistries*	✓	✓	✗	✗	✗
Clean Conditions	DaeClean™ 300 (Safe Solvent)	DaeClean™ 300 (Safe Solvent)	RT DIW	80C, DIW	DaeClean™ 150 (Detergent)



# Summary

- Washable coatings to support temporary protective coating or bonding applications
- Degree of crosslinking, process temperature influence ability to easily wash off substrate
- Polymeric system's chosen based on customer's process conditions
- Select those systems that exhibit enough robustness, easy washability



# 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.
- Diversified Applications Engineering Technologies (DAETEC)  
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