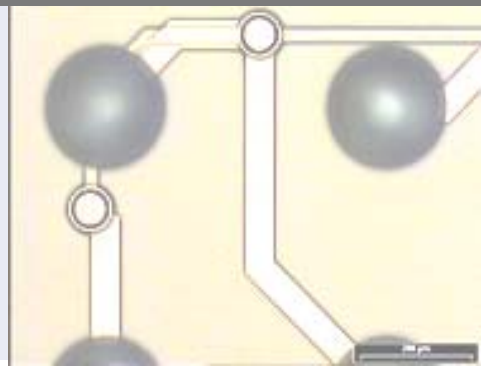
DuPont Wafer Level Packaging

Materials Charaterization for Thin Wafer Processing

presented by,
Chris Milasincic
Global New Business Development Manager
HD MicroSystems
2009. July 13th



SÜSS MicroTec

HD MicroSystems

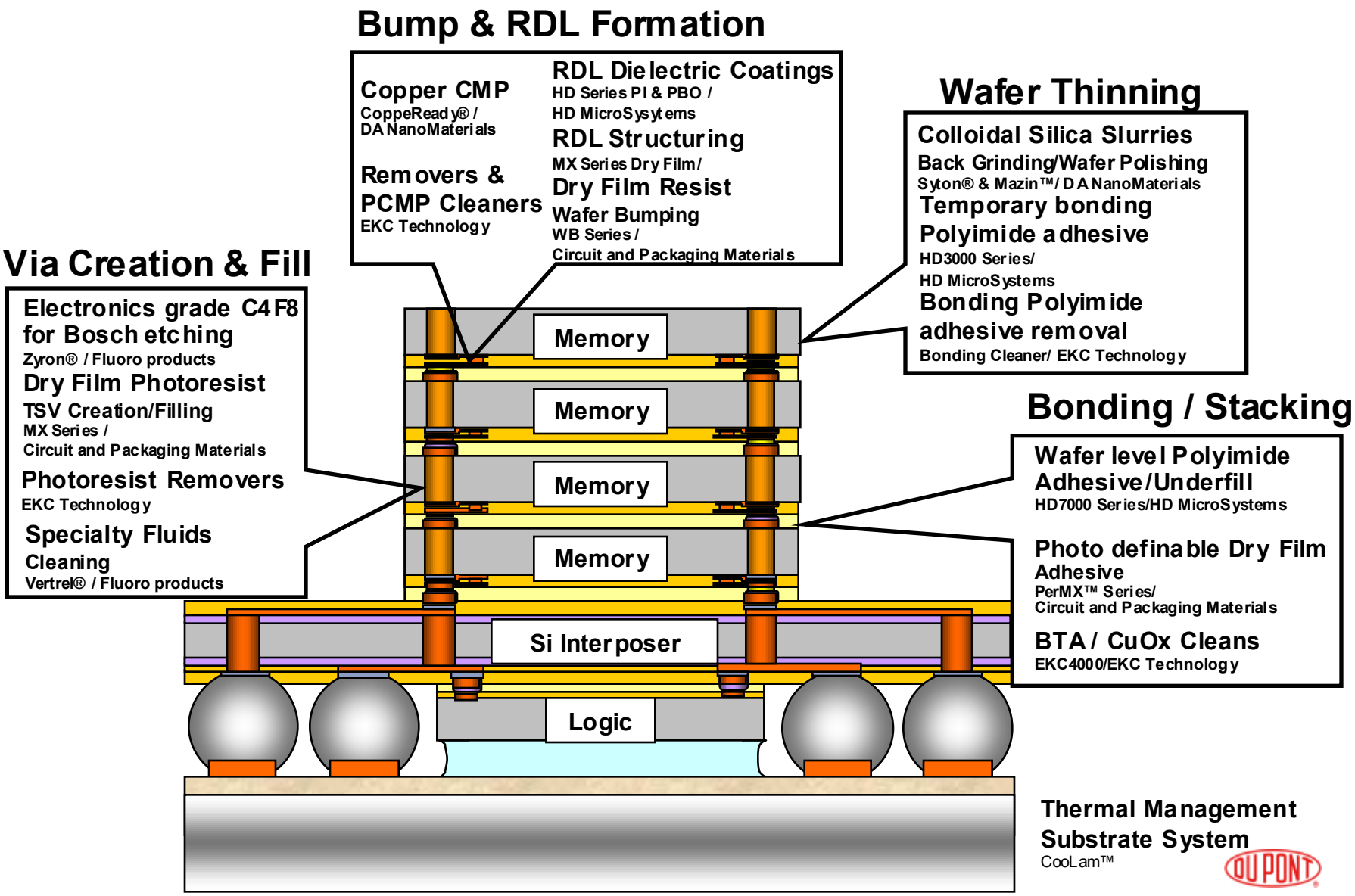
DUPONT
The miracles of science™

DuPont Wafer Level Packaging
High temperature temporary bonding solutions

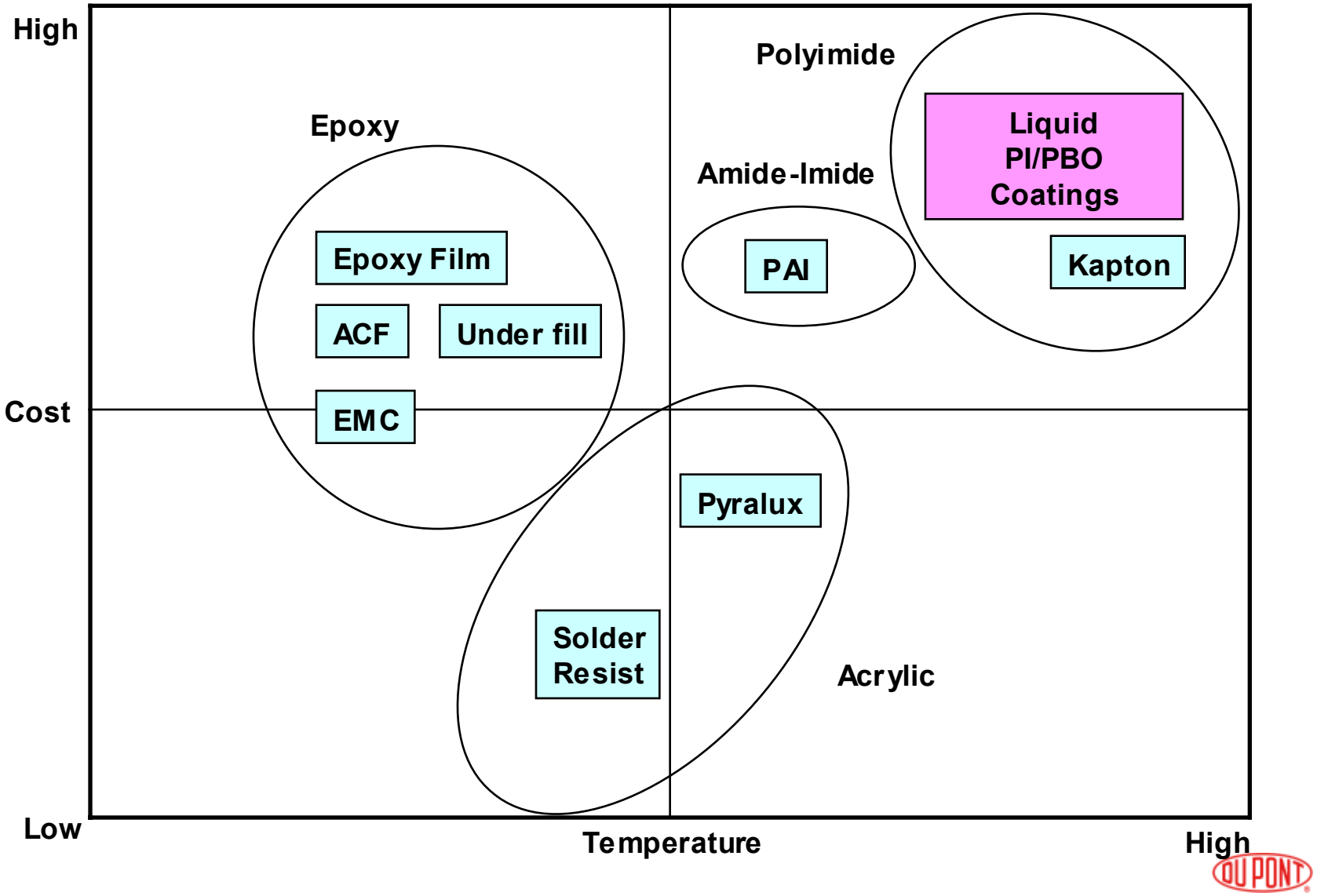
AGENDA

- DuPont Materials for 3D/TSV
- HDM Polyimide Adhesives for 3D/TSV
- Avoiding Thin Wafer Handling
- DANM Slurries for Backside Grind
- EKC Post Backside Grind Cleaner
- EKC Pre bonding BTA/CuOx Cleaner
- EKC HDM Polyimide Adhesive Remover

DuPont Wafer Level Packaging
Materials Characterization for Target Applications



Organic based Adhesives Product Mapping
Advantage of PI adhesives



Temporary bonding Polyimide
HD3007 Example of end properties

Property/Condition	Units	HD-3007
Liquid Viscosity	St	8-10
Weight Solids	%	25-30
Cure Temp Range	°C	250-350
Bonding Temp Range	°C	300-350
Bonding Press	N/cm^2	>14-22
Contact time	minutes	5-10*
Cured Dielectric Thickness	microns	2-20
Glass Transition Temp (Tg)	°C	188
Weight loss @ 350C	%	0.2
CTE	ppm/ °C	60
Dielectric Constant	z	3.4
Tensile Strength	Mpa	140
Modulus	Gpa	3.6
Thermal Conductivity	W/m*K	0.2

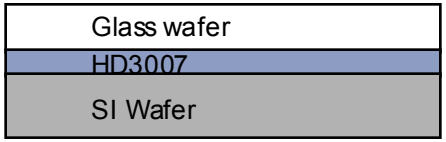
* Bond times dependent on adhesive thicknesses used
- Thicker adhesive layers will bond faster
- Thinner adhesive layers will bond slower

Wafer Bonding HD-3007 – Test Matrix

Test Wafers:
Wafer ID: 6715

- **Bonding Process:**
  Preheat top chuck to 300 °C
  Preheat bottom chuck to 180 °C
  Load bond tool to bond chamber
  Evacuation on (no wait for certain value)
  Heat bottom chuck to 300 °C
  Wait until temperature >= 300 °C
  Wait 3 min
  Move separation flags out
  Wait for 15 s
  Piston down (top chuck starts pressing on glass wafer)
  (2000 N/min, maximum pressure 6900 N)
  Wait for 1 min
  (top chuck stops pressing on glass wafer)
  Purge N_2
  Cooling to 180 °C
  Unload bond tool from bond chamber

  Piston up
- **Required time for chamber process: 10 min**



Result: good,
300°C is working well

Courtesy of IZM Fraunhofer

Polyimide based permanent bonding adhesives HD7000series Example of end properties

Property/Condition	Units	HD7002	HD-7010
Liquid Viscosity	Pa· sec.	2	4
Weight Solids	%	25-40	25-40
Cure Temp Range	°C	250-350	250-400
Bonding Temp Range	°C	250-350	250-350
Bonding Press	N/cm^2	>14-22	>14-22
Contact time	minutes	5-10*	5-10*
Cured Dielectric Thickness	microns	2-20	2-20
Glass Transition Temp (Tg)	°C	172	260
5% Weight loss Temp.	°C	413	395
CTE	ppm	80	70
Dielectric Constant	z	3.3	3.3
Tensile Strength	Mpa	152	173
Modulus	Gpa	2.6	2.6
Elongation	%	100	70
Thermal Conductivity	W/m*K	0.2	0.2

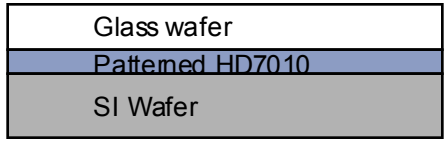
* Bond times dependent on adhesive thicknesses used
- Thicker adhesive layers will bond faster
- Thinner adhesive layers will bond slower

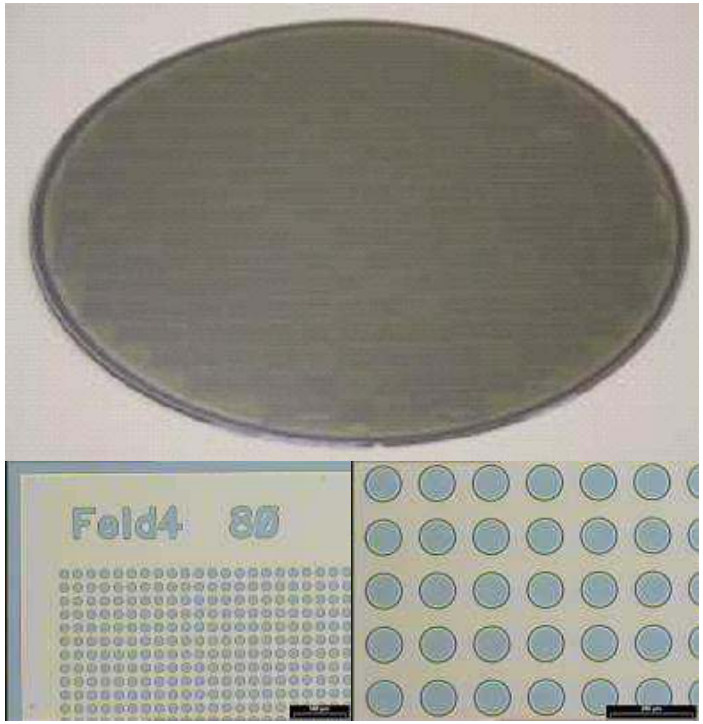
Wafer Bonding HD-7000 Series – Test Matrix

Wafer Bonding with HD7010

Results: Test 18 Wafer ID 7242

- **Bonding Process:**
  Preheat top chuck to 250 °C
  Preheat bottom chuck to 180 °C
  Load bond tool to bond chamber
  Evacuation on (no wait for certain value)
  Wait for 8 min (pre-bake in chamber)
  Heat bottom chuck to 250 °C (30°C / min)
  Wait until temperature >= 250 °C
  Wait 3 min
  Move separation flags out
  Wait for 15 s
  Piston down (top chuck starts pressing on glass wafer)
  (2000 N/min, maximum pressure 6900 N)
  Wait for 10 min
  Piston up (top chuck stops pressing on glass wafer)
  Purge N_2
  Cooling bottom chuck to 180 °C
  Unload bond tool from bond chamber

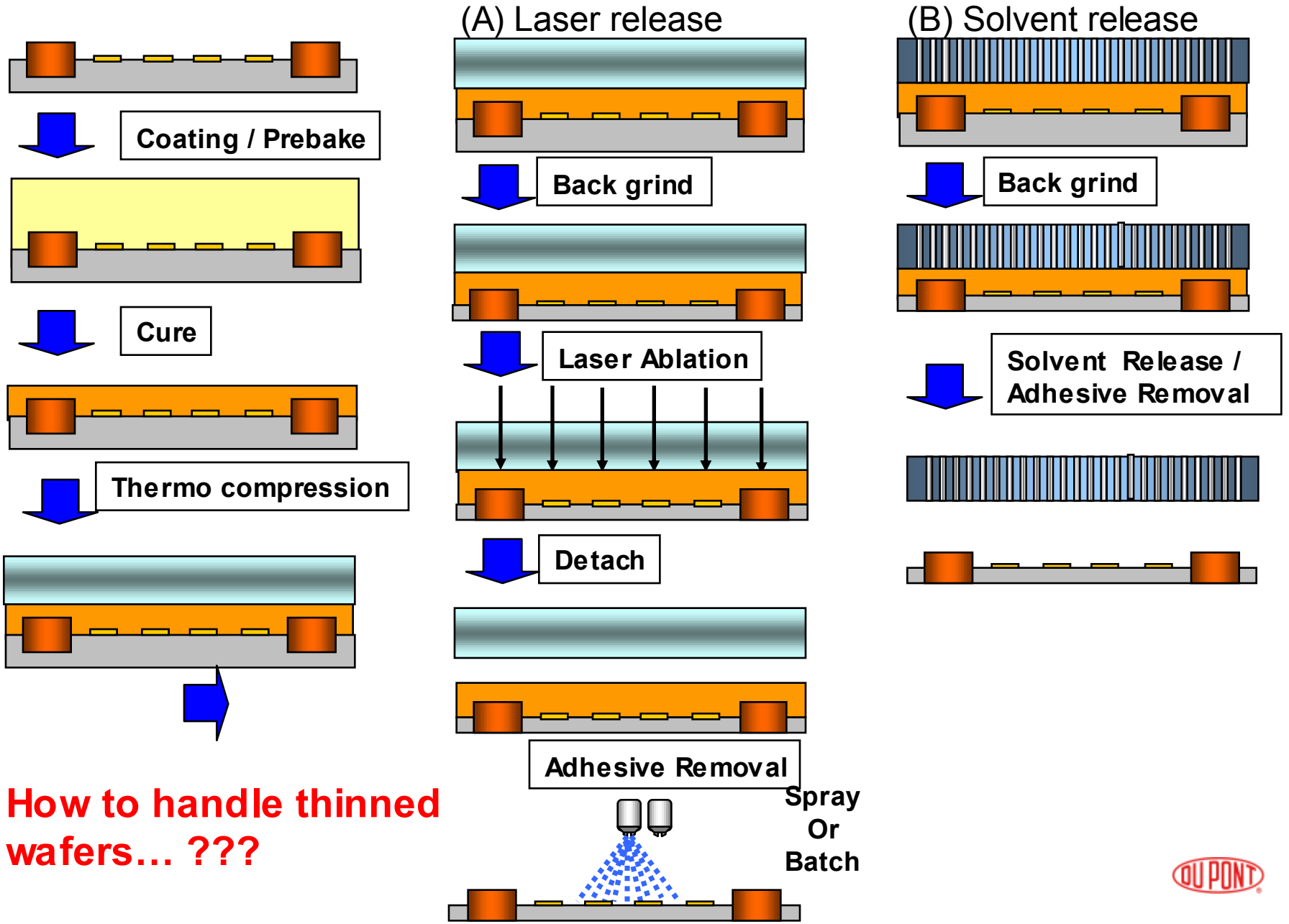




Courtesy of IZM Fraunhofer

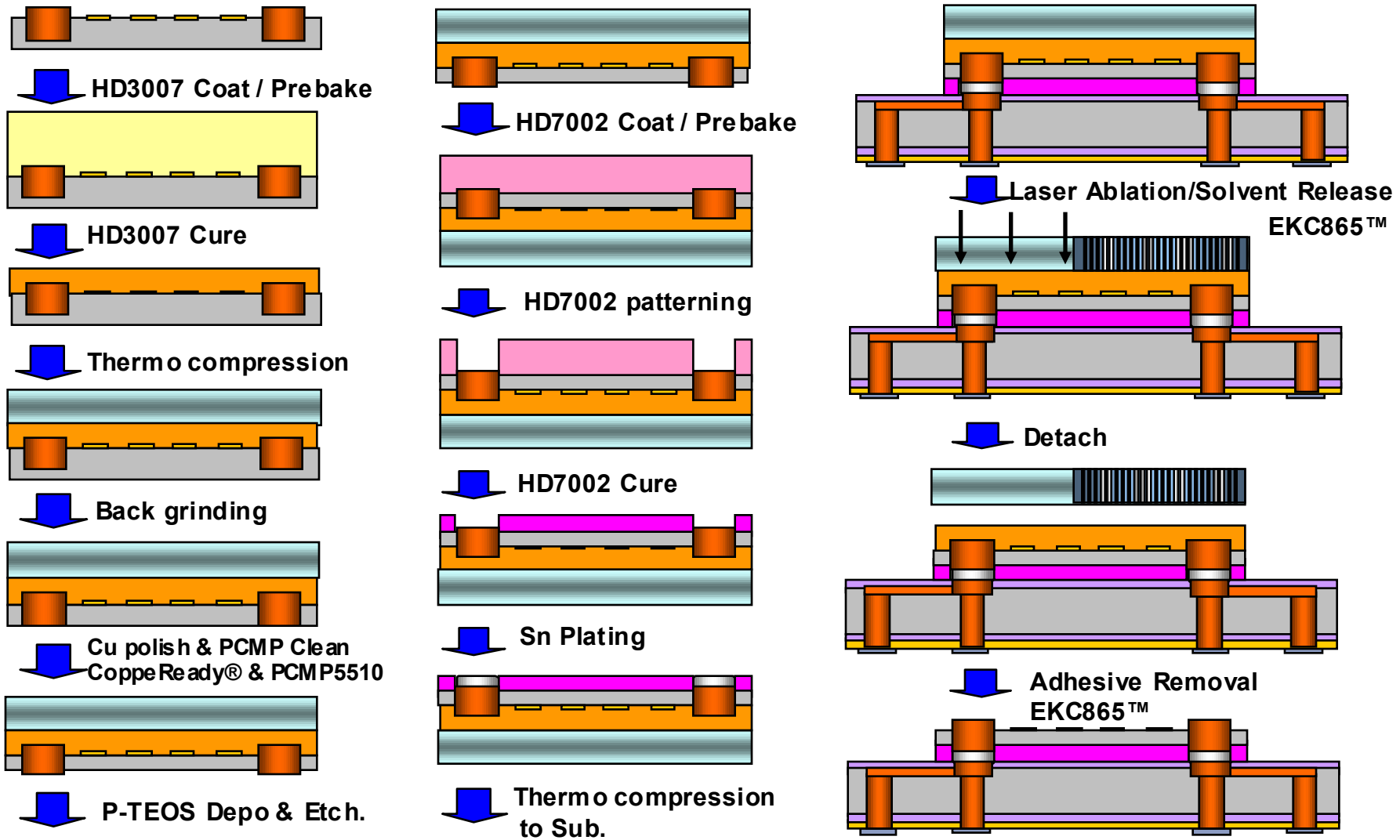
Result:
Succeeded bonding a patterned HD7010 to glass w/o voids

Prior Temporary Bonding Scheme



How to handle thinned wafers… ???

Improved Temporary Polyimide Adhesive Wafer Thinning Process (Eliminates thin wafer handling)

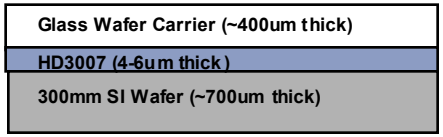


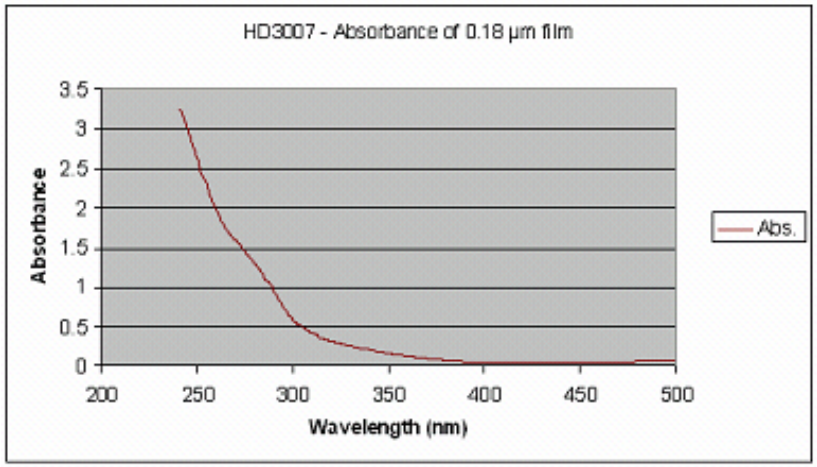
HD-3007 Laser Release Data

Laser lift-off of glass carrier from Si wafer has been carried out at the fluence of 200 and 225 mJ/cm2.

Process Parameters :

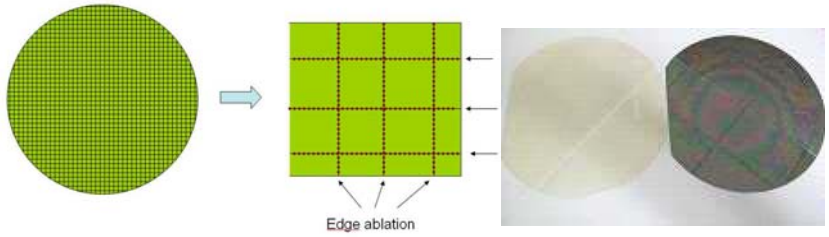
- Wavelength : 248 nm (KrF)
- Fluence : 200 and 250 mJ/cm2
- Size of beam spot : 5.0 × 1.3 mm2
- Number of pulse : single pulse
- Machining method : step and repeat with overlap of 100 µm





Reference:

- Tamarack successfully performed wafer debonding, including wafer-edge de-activation in AP-278B, they de-bonded the wafers in two steps:
  - 1- Fully ablate the wafer in the X-direction After ablation in the X-direction is complete; rotate the wafer 90 degrees.
  - 2-Fully ablate the wafer in the Y-direction (see diagram below):



Important: Clean glass carrier surface to insure that it does not contain any dirt, spots, etc. that could inhibit the laser light from reaching the adhesive layer.

HD-3007 Laser Release Data

Tamarack Laser De-bonding

Wafer De-bonding Throughput Example:

HD Micro - Throughput and CoO Summary
Tamarack Model 414 Excimer Laser De-Bonding System
Matthew Gingerella 5/2/2009

(300mm Wafers) Throughput and TCO Estimates

	Tamarack Model 414 with LSX 200K Laser
Beam Size:	1.5mm x 120mm
Machine Capacity (wafers/year)	686,758
Throughput (wafers/hour)	110.00

Process Assumptions:	TCO Assumptions:
LSX 200K Laser (248nm, 670mj)	20 hr/day
200mJ/cm^2,1-Pulse Ablation	6 days/week
Two Passes	52 weeks/yr
1.5mm x 120mm Laser Beam	6-Year Depreciation
Manual Load/Unload	Does not include Laser Gases
	Standard Model 414 De-Bonder

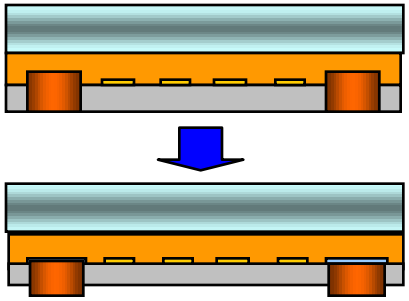
TAMARACK scientific co., inc.

DUPONT

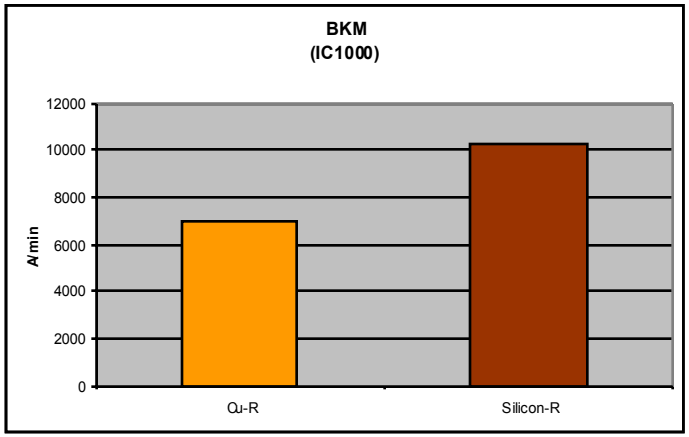
DANM Selective Cu polish Slurry can eliminate additional plating process for bump

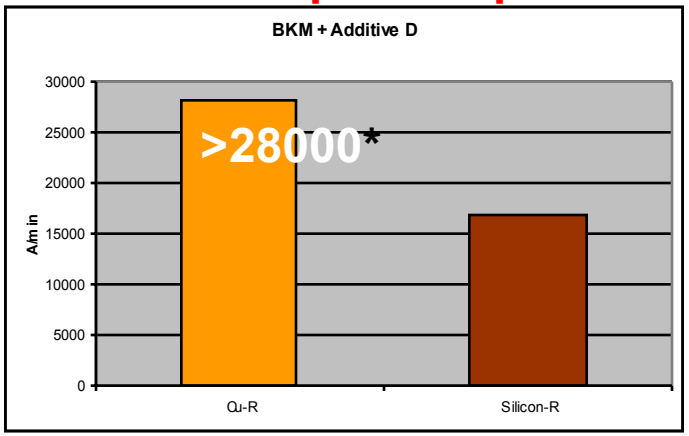
Slurry Target Specifications:

- **Si Removal rates : 2-2.5 μm/min**
- **Selectivity Si:Cu : 1:1**



Self Cu bumps after polish





Cu and Si RR is tunable.

Current best formulation is Si:Cu of 1:1 @ 16000 A/min using Additive D (need to optimize conc. of D to lower Cu etch rate).

PCMP5510™ Post Grind/Polish Metallic Contamination Removal

TOF-SIMS Analysis for Residual Copper

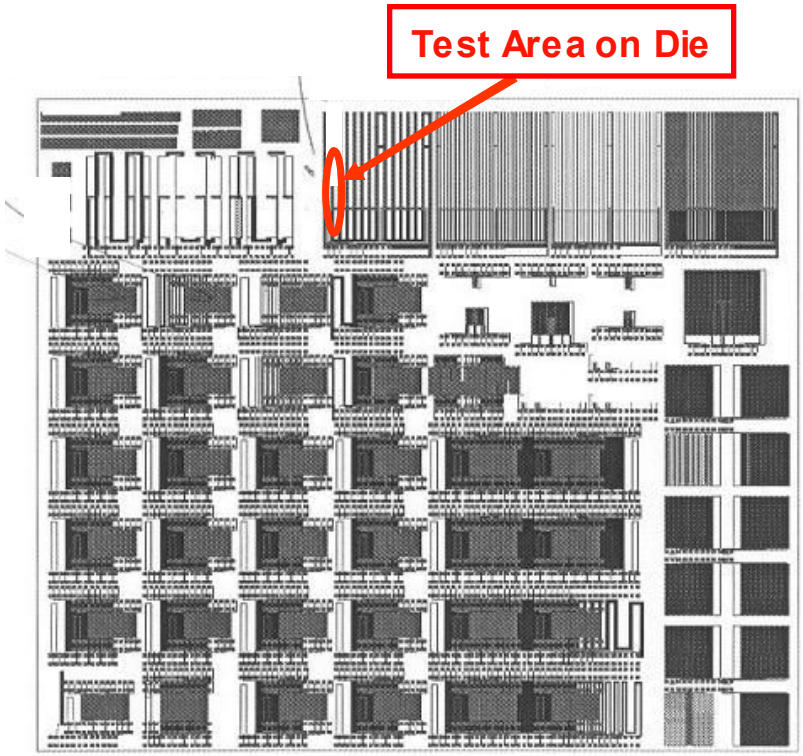
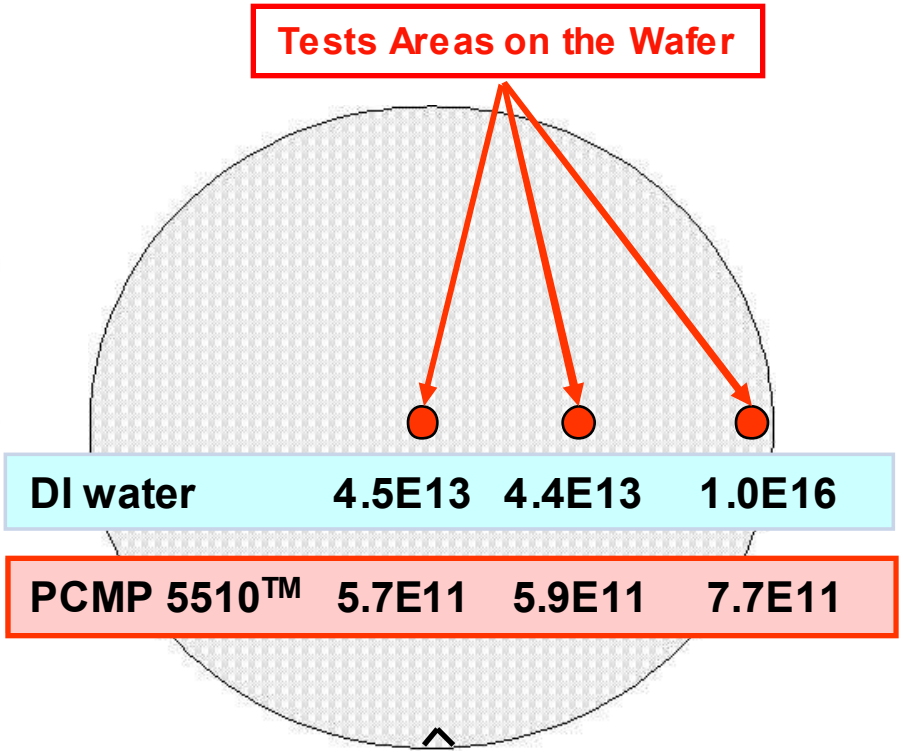


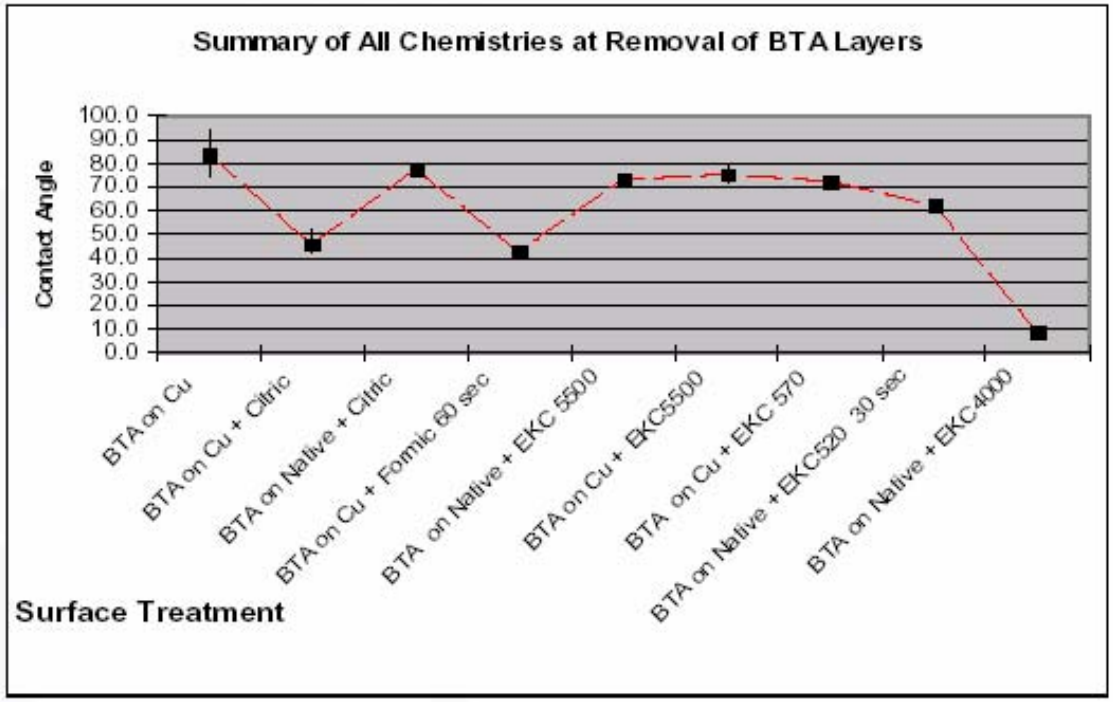
Figure 2 Mask Floor Plan: low-K/Cu Mask



Excellent Trace Metal Cleaning Performance

EKC4000™ BTA/Cu Oxide Cleaner For Cu - Cu Bonding

BTA Removal Summary



- Citric and Formic are equally mediocre at removing BTA layers.
- EKC 4000 appears to be excellent at removing BTA and underlying oxide layers.

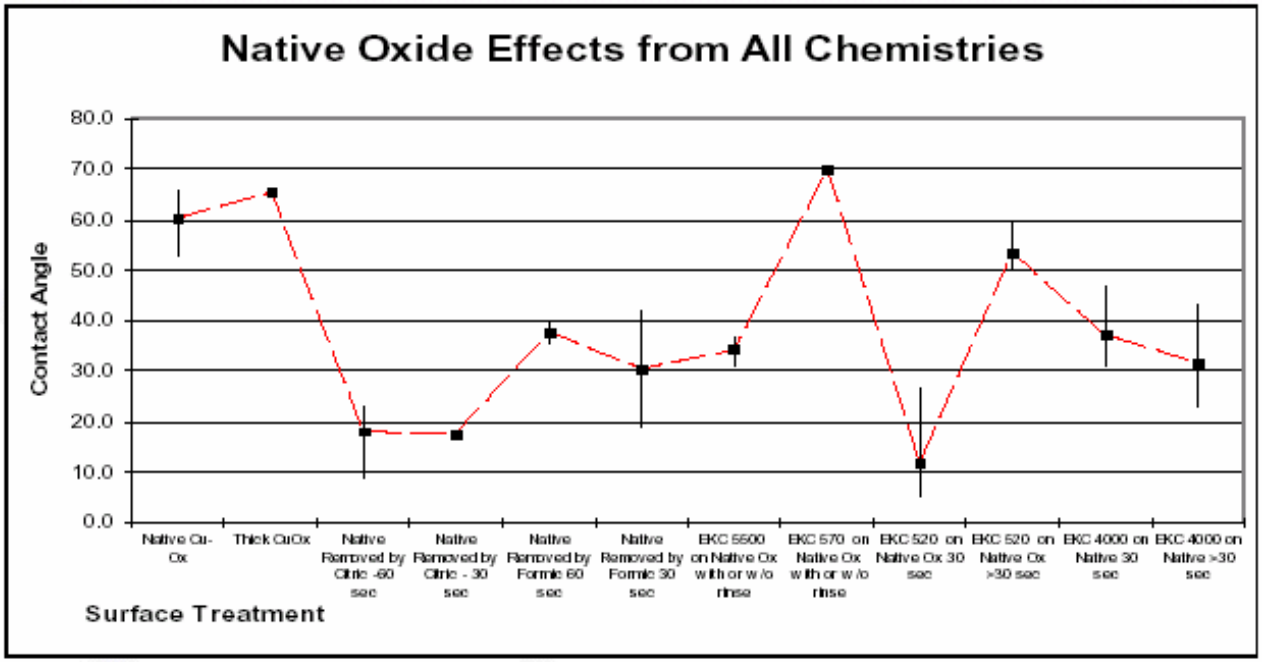
SUSS MicroTec

Suss Confidential

DUPONT

EKC4000™ BTA/Cu Oxide Cleaner For Cu - Cu Bonding

Oxide Removal Summary



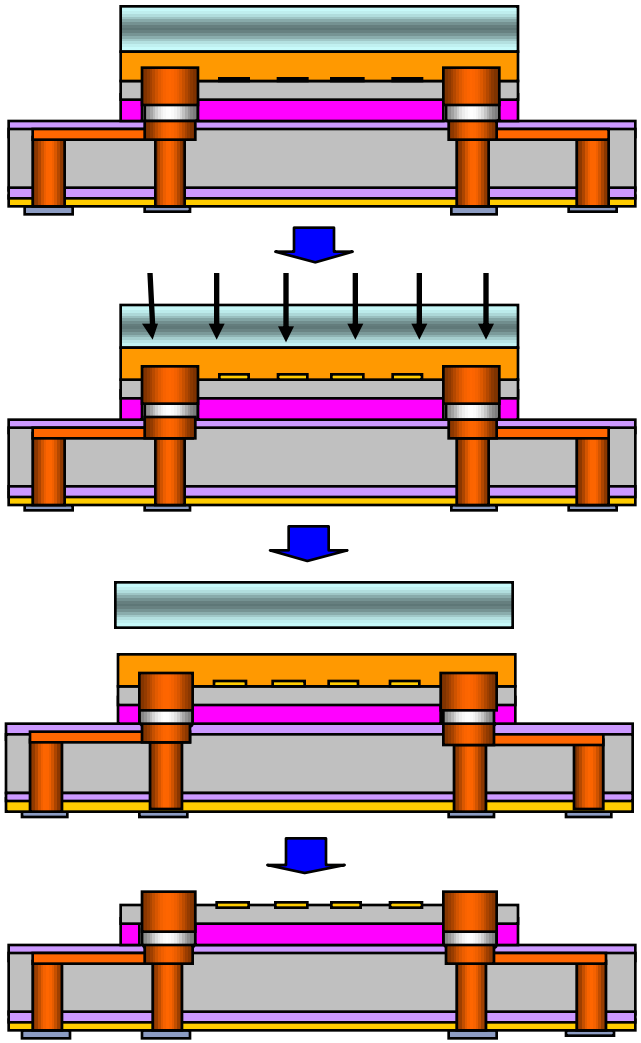
- Citric Acid is best for removal of oxides as is EKC 520
- Formic and EKC 4000 are roughly equivalent.

SÜSS MicroTec

Suss Confidential

DUPONT

EKC865™ Selective Adhesive Remover



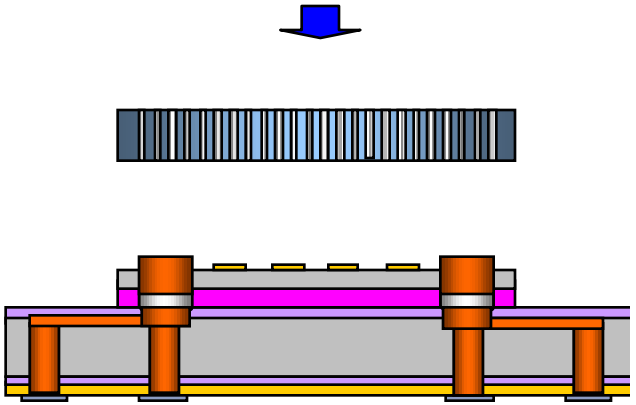
Flip down and bond to substrate/die

Laser ablation for release

Detach glass sub.

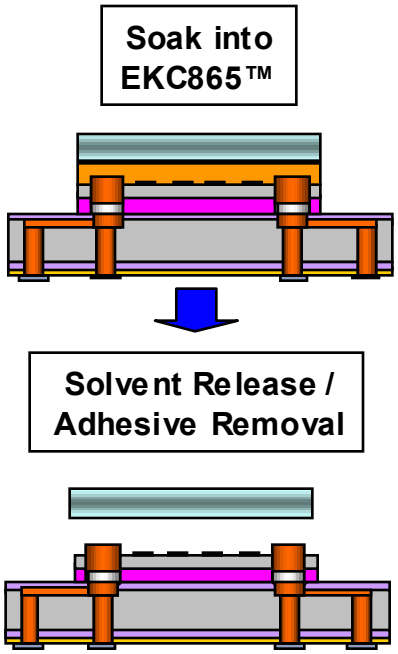
Adhesive Removal
EKC865™ Adhesive Remover

Solvent Release & Adhesive Removal
EKC865™ Adhesive Remover

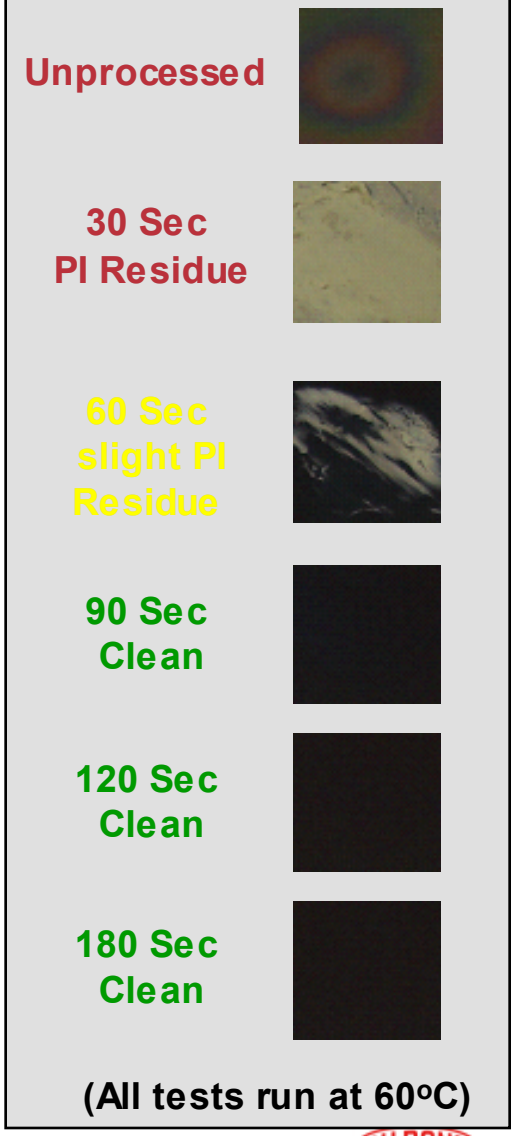


EKC865™ Selective Adhesive Remover for HD3007

Proposed Solvent Release



- **Test Wafer Process Conditions**
  - HD3007 thickness = 8um (4um standard thickness)
  - Cured at 200-240°C
  - De-bonded via laser ablation
  - Additional pieces of silicon wafer coated with HD4100 (blanket and patterned) and cured at 350°C were also tested for compatibility
- **Cleaning Results**
  - Rapid Cleaning at 60C for a time of 60-180 secs
  - Compatible with HD4001 cured at 350°C
    - Tested at 60°C for 30min with no attack to HD4001
  - Excellent Compatibility to Sensitive Metal Films
    - Aluminum, Copper, Titanium, Nickel, Chrome, Tungsten, & other Metal Alloys
- **Chemistry can be re-circulated in a closed loop system**
- **Water rinseable**
- **Can be utilized in both automated and manual wet cleaning equipment platforms**



Thanks for your attention !!