Low Cost, Room Temperature Debondable Spin on Temporary Bonding Solution: A Key Enabler for 2.5D/3D IC Packaging

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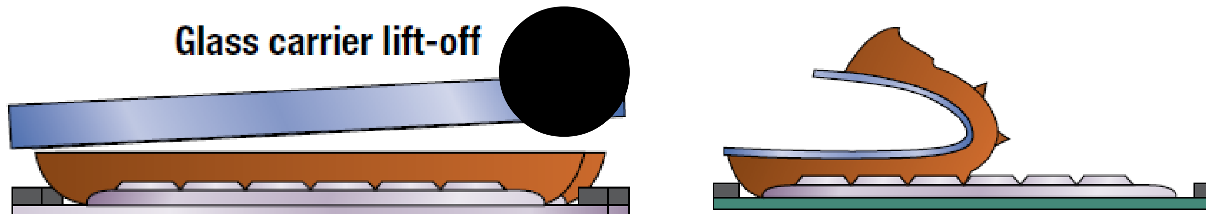
Outline

- Background
- Why A Dow Corning Temporary Bonding Solution
- Dow Corning Temporary Bonding Process
- Experimental Results
- Conclusions
- Acknowledgements

Background

Perforated Carrier Temporary (De)Bonding Technology

Thermoplastic Temporary (De)Bonding Technology



Glass Carrier Temporary (De)Bonding Technology

Why A Dow Corning Temporary Bonding Solution (TBS)

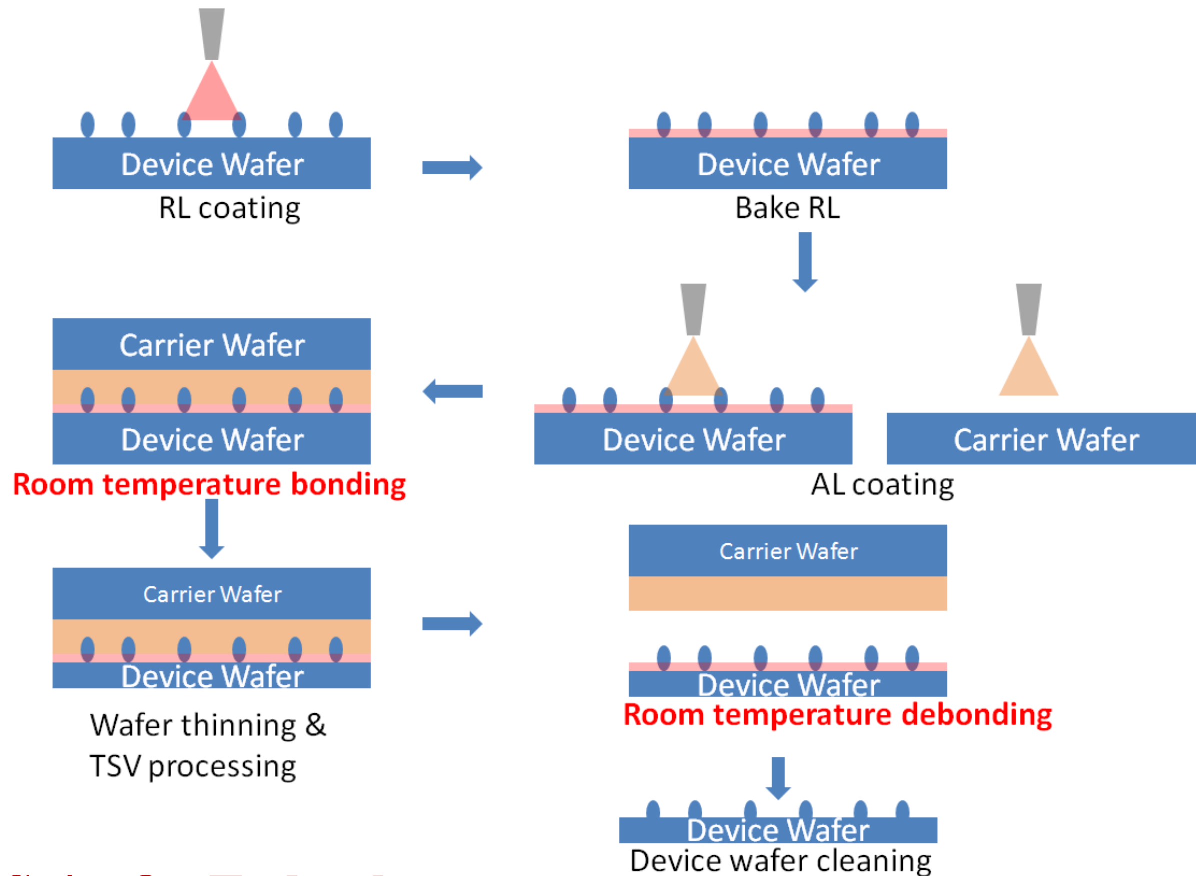
Requirements

- Thermal Stability
- Chemical Stability
- Excellent Adhesion for withstanding Wafer Thinning
- Global TTV of 2µm or less across thin wafer
- Low Temp. Debonding
- Easy Wafer Cleaning

Dow Corning TBS Properties

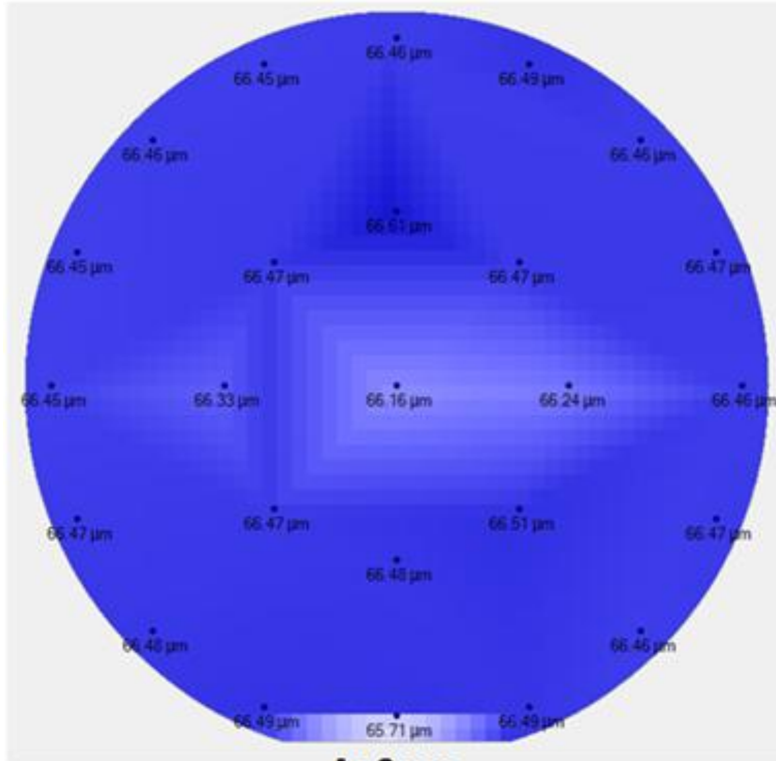
- Thermally Stable
- Chemically Stable
- Wafer Thinning - 50 µm
- Global TTV – 2 µm (stack)
- Room Temp Bonding
- Room Temp. Debonding
- Easy Wafer Cleaning

Dow Corning Temporary Bonding Process

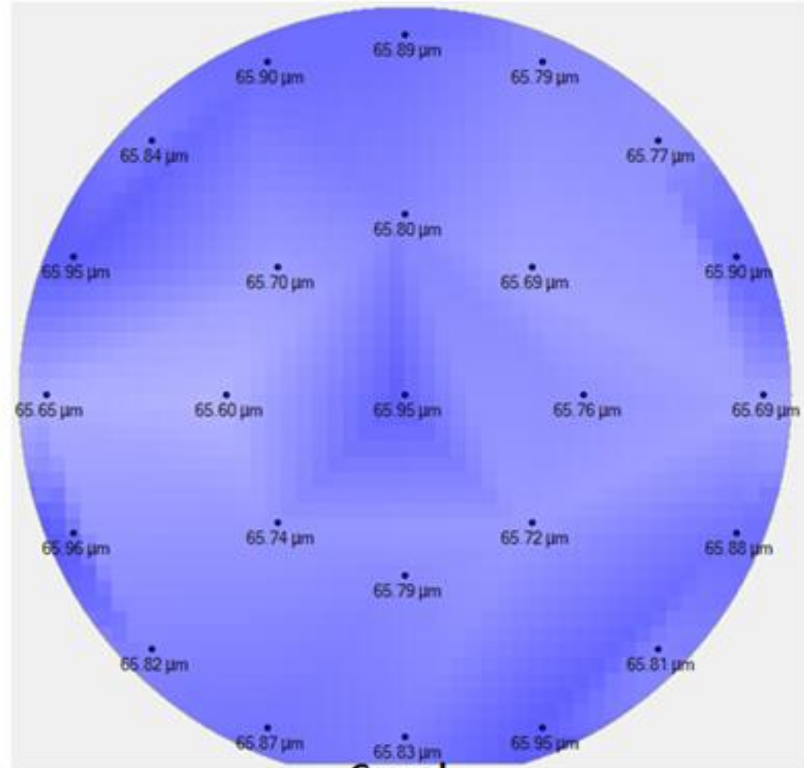


- Simple Spin-On Technology
- No Adhesive on Device Wafer after debonding
- No Additional Wafer Processing or Equipment for pre-processing of wafers

200 mm Spin Coating Evaluation



As Spun



Cured

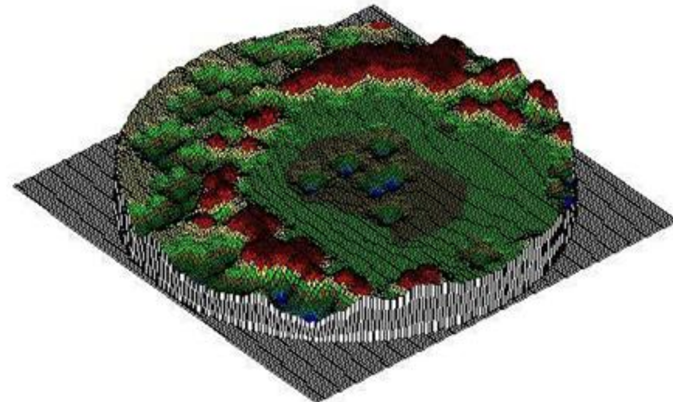
As Spun

Max = 66.61
Min = 65.71
TTV = 0.9
Uniformity = +/- 0.7%

Cured

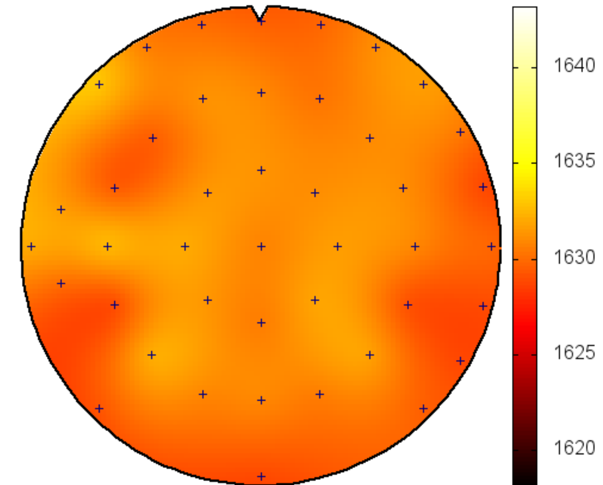
Max = 65.96
Min = 65.60
TTV = 0.36
Uniformity = +/- 0.3%

300 mm Coating & Bonding Test



As Spun
68 µm after spin coating
TTV = 0.84um

Mean = 1630.6 microns, TTV = 4.1 microns



Typical < 5um TTV for un-optimized carrier bonding using a ~68um bonding layer

- Release layer = 0.2 um & Adhesive layer = 68 um

- Most recent demonstration – Post Wafer Thinning
  - 2 um TTV with 50 um adhesive layer on 50 um thin wafer
  - 2 um TTV on 50 um thin wafer with 45 um bumps
  - 3 um TTV on 50 um thin wafer with 70 um bumps
  - TTV is device wafer configuration dependent

TTV of 50 µm Thin 300 mm Blanket Wafer – After Backgrinding

Thicknesses (µm)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
							Notch							
							L1							
			L6				0.873				L2			
				0.874			0.875			0.874				
	L5			0.875			0.875			0.875			L3	
		0.875			0.875				0.875			0.875		
			0.875		0.875		0.875		0.875		0.875			
				0.875		0.875	0.875	0.875		0.875				
					0.875	0.875		0.875	0.875					
L4	0.875	0.875	0.875	0.875	0.875				0.875	0.875	0.875	0.875	0.875	L4
					0.875	0.875		0.875	0.875					
				0.875		0.875	0.875	0.875		0.875				
			0.875		0.875		0.875		0.875		0.875			
		0.874			0.875				0.875			0.874		
	L3			0.875			0.875			0.875			L5	
				0.873			0.875			0.873				
			L2				0.873				L6			
							L1							

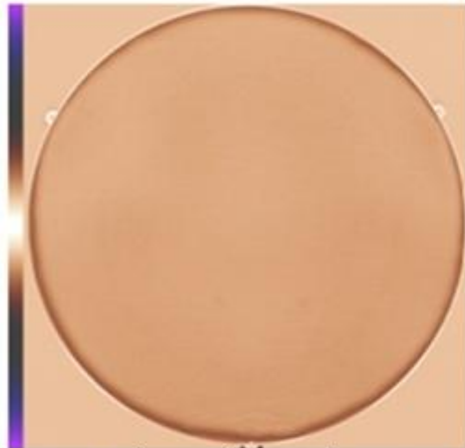
2 µm TTV with 5 mm edge exclusion

300 mm Wafer Thinning Performance

50 micron bonded stack

No Edge Chipping on non-edge trimmed wafers

Thermal Stability of 50 µm 300 mm Thin Bonded Pair



Before Thermal

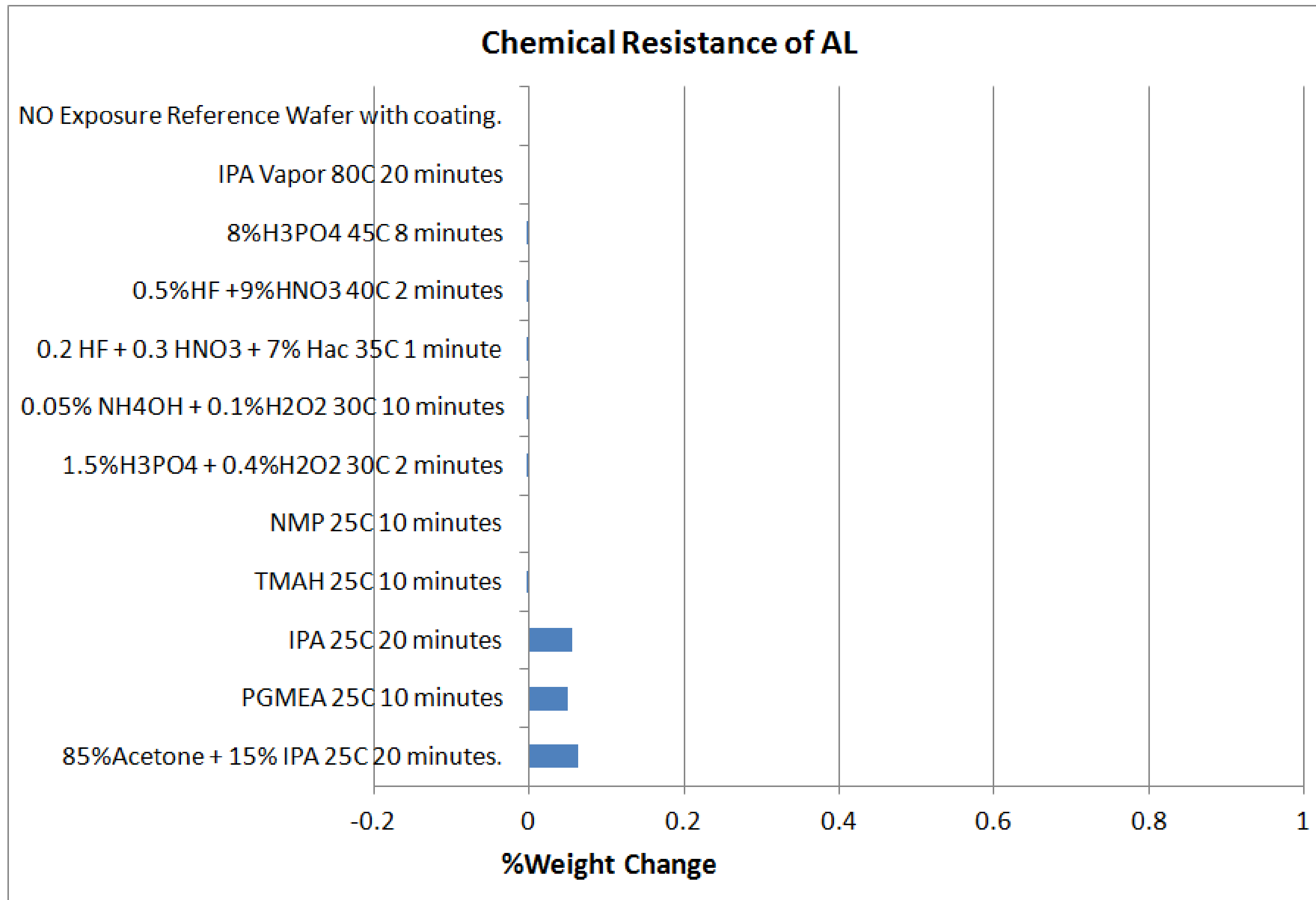
200C – 20 mins

260C – 10 mins

200C – 3 hours

No Voids or Delamination

Chemical Resistance

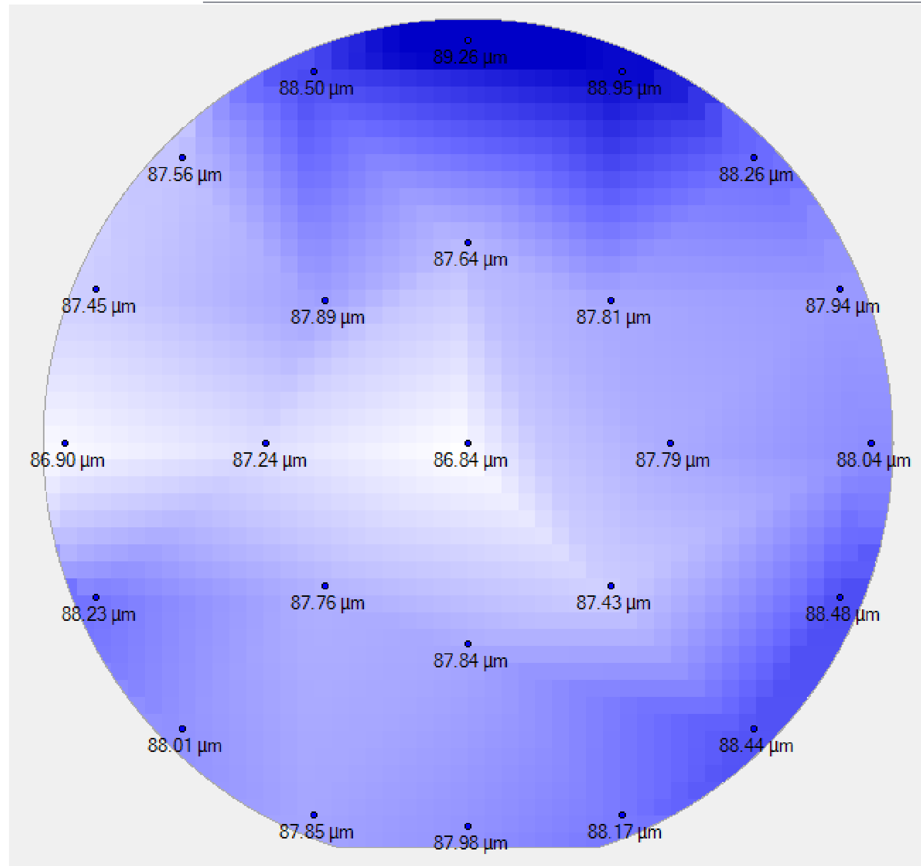


Adhesive Bond Layer shows good resistance to common chemicals used in the post grind processing.

Chemical Resistance of Bonded Pair

No delamination seen of bonded pair during solvent soak test

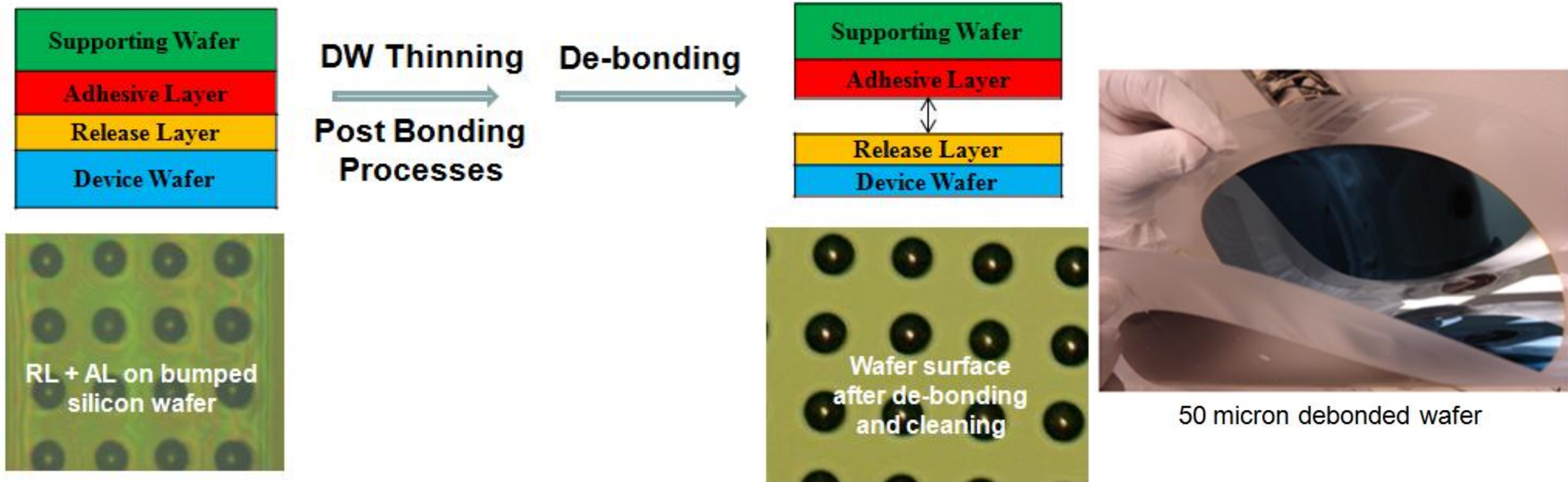
Adhesive Layer (AL) After Chemical Treatment



Wafer Map of AL of debonded wafer after Chemical Soak Test
-No Loss of AL, TTV of AL ~ 2.4 micron

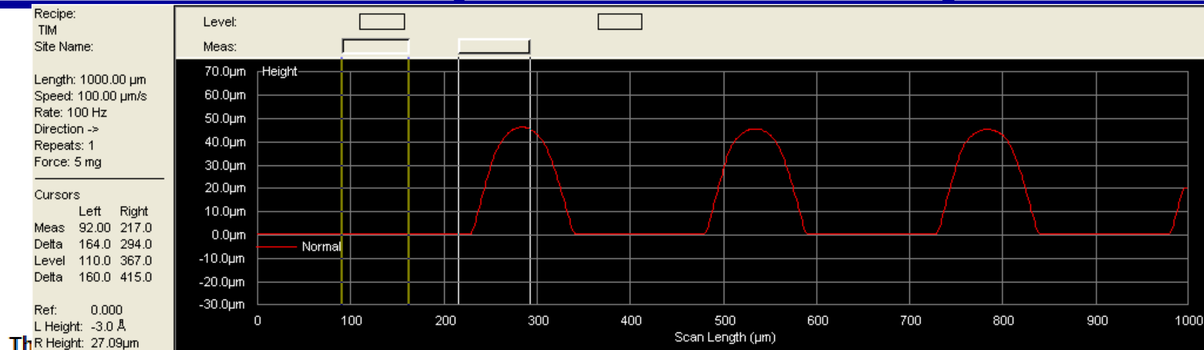
De-Bonding Process

- Simple Room Temp.de-bonding process steps:
  - Automated mechanical de-bonding at room temperature
    - Performed on SUSS MicroTec DB300T and DB12T de-bonders



50 micron debonded wafer

TTV of 50 µm Back Ground 300 mm wafer with 45 µm Tall Bumps



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
							Notch							
							L1							
			L6				0.891				L2			
				0.891			0.891			0.891				
	L5			0.891			0.890			0.890			L3	
		0.891			0.890				0.890			0.891		
			0.891		0.890		0.890		0.890		0.890			
				0.890		0.890	0.890	0.890		0.890				
					0.890	0.889		0.889	0.890					
L4	0.891	0.891	0.890	0.890	0.890				0.890	0.890	0.890	0.891	0.891	L4
					0.890	0.890		0.890	0.890					
				0.891		0.889	0.890	0.890		0.890				
			0.891		0.890		0.890		0.890		0.891			
		0.891			0.890				0.890			0.891		
	L3			0.891			0.890			0.890			L5	
				0.891			0.891			0.890				
			L2				0.891				L6			
							L1							

2 µm TTV on 50 µm thin wafer 5 mm edge exclusion

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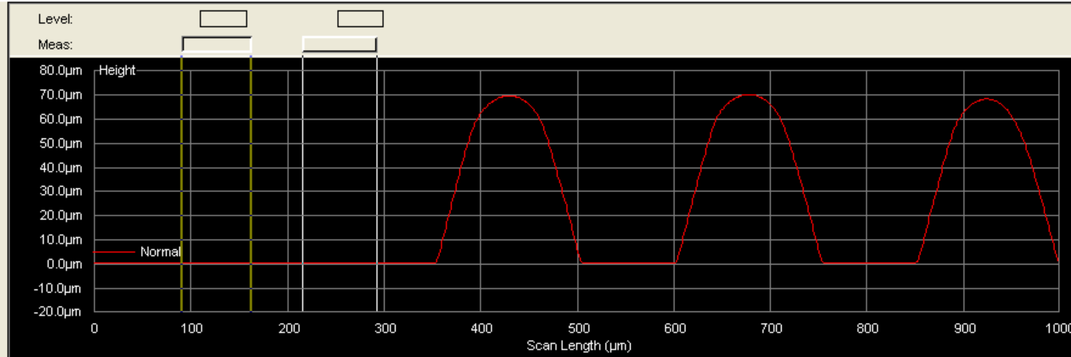
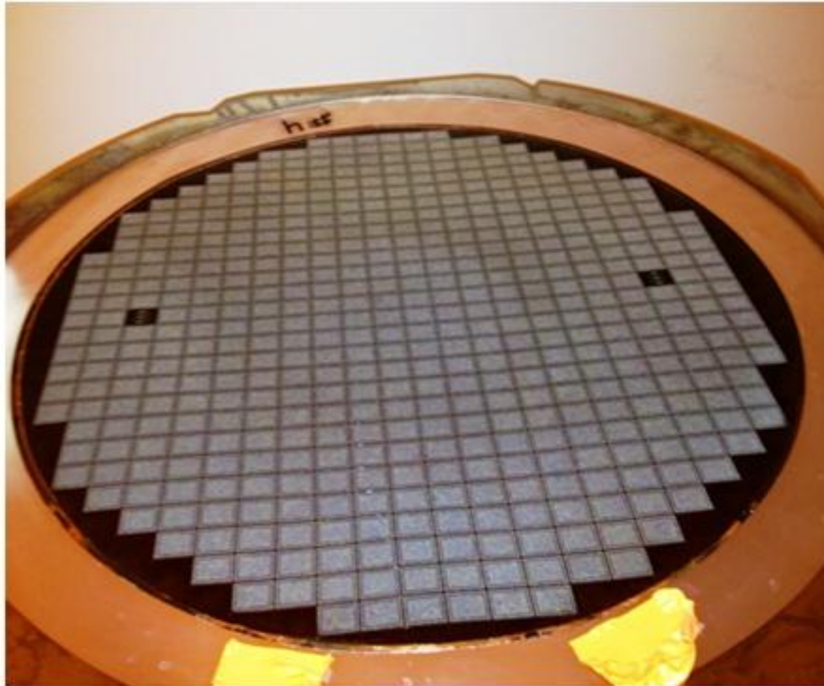
TTV of 50 µm Back Ground 300 mm wafer with 70 µm Tall Bumps



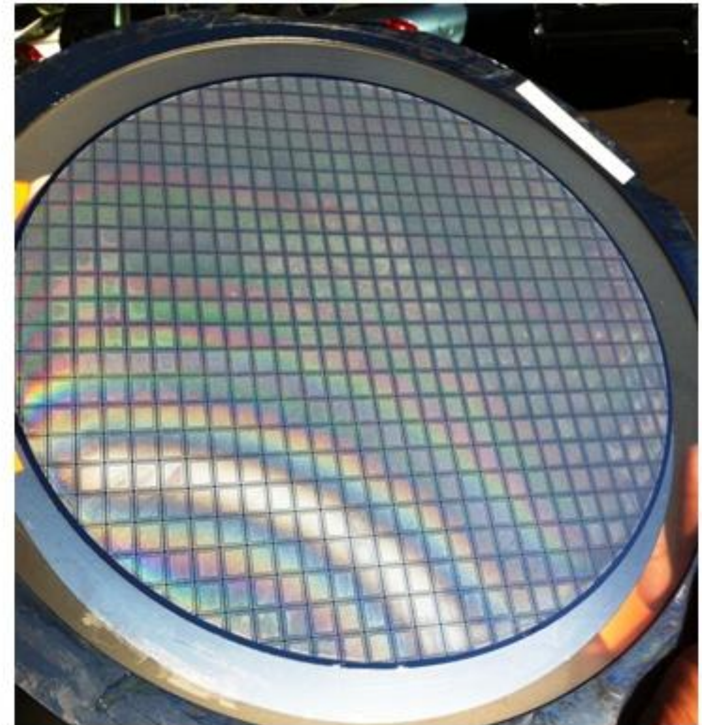
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
							Notch							
							L1							
			L6				0.924				L2			
				0.924			0.924			0.924				
	L5			0.924			0.923			0.924			L3	
		0.924			0.923				0.923			0.924		
			0.924		0.923		0.923		0.923		0.924			
				0.923		0.922	0.923	0.922		0.923				
					0.923	0.923		0.923	0.923					
L4	0.924	0.924	0.923	0.923	0.923				0.922	0.923	0.923	0.924	0.924	L4
					0.923	0.922		0.923	0.923					
				0.923		0.923	0.922	0.923		0.923				
			0.924		0.923		0.923		0.923		0.924			
		0.925			0.923				0.923			0.924		
	L3			0.924			0.923			0.924			L5	
				0.924			0.924			0.924				
			L2				0.924				L6			
							L1							

3 µm TTV on 50 µm thin wafer 5 mm edge exclusion

Debonded Thin Bumped Wafer



50 µm thin wafer with 70 µm tall bumps



50 µm thin wafer with 45 µm tall bumps

Crack Free Debond

Process Survey

Production Readiness	Cost of Ownership	Performance	Temperature
Categorized:	Calculated:	Weighted:	
1 : Qualified /used for high volume manufacturing 2: Integration tests in line at institute 3: Qualified by SUSS internal tests	Equipment cost Process times & cycles Other consumables: e.g. Cost of Tape (Cost of materials)	Process Latitude (Survivability / Debondability) Achievable min. wafer thickness (TTV)	Max. temperature for post processing

Cost Of Ownership

Readiness level

Qualified/Used for High Volume Manufacturing

Integration tests at Institute

Qualified with SUSS test criterias

C

D

B

A

F

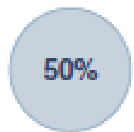
E

G

H

7,00 6,00 5,0 2,50 1,50 0,50

Cost of Ownership (normalized to 1 for best process)



Performance (TTV / Process Latitude)

100%: Si TTV 1µm & all bump sizes / layers more or less plug and play

Max. Temperature

- 500°C
- 400°C
- 250°C
- 200°C

Conclusion

Dow Corning Temporary Bonding Solutions is offering:

- Simple bi-layer structure for a temporary bonding solution
  - **No wafer pretreament**
- Excellent uniformity for thick layers
  - **Less than 1 µm TTV for coated bonding material prior to bonding**
- Fast **room temperature** bond
  - **TTV of 2-3 µm micron demonstrated on 50 µm thin bumped wafer stack**
- Good thermal & chemical characterisitics
  - Thermal stability demonstarted in air and vacuum ambient
  - Chemical stability demonstrated with respect to TSV process chemical
- Fast mechanical de-bonding with a high throughput potential
  - Easy **room temperature** de-bond

Acknowledgments

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