

CHARACTERISATION OF A NEW ADHESIVE – PERMINEX 1005 FOR WAFER BONDING

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Ltd.**



OUR OBJECTIVES

- ✓ Low temperature process
- ✓ High quality, void free bonding
- ✓ $\leq 1\mu\text{m}$ post bond alignment accuracy
- ✓ Reduced bond cycle time

POSSIBLE PROBLEMS WITH ADHESIVES

- ✓ Application – roller, screen printing
- ✓ Adhesion – beading effect, needed adhesion promoters
- ✓ Short time window between application and bonding
- ✓ Problematic alignment due to adhesive acting like a lubricant
- ✓ Bond line broadening – excessive flow, need for exclusion zone
- ✓ Long process – slow curing
- ✓ Price and short shelf life

PERMINEX 1000 SERIES OVERVIEW

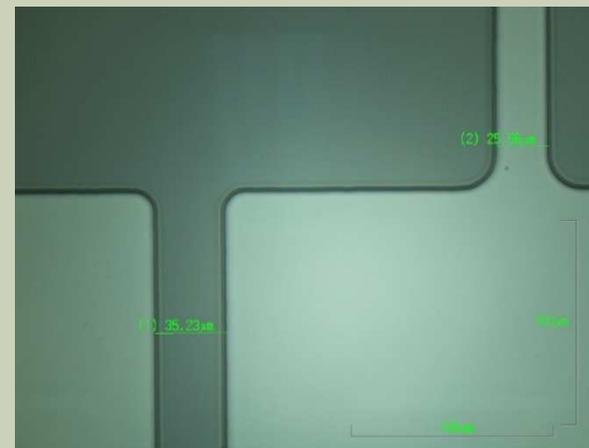
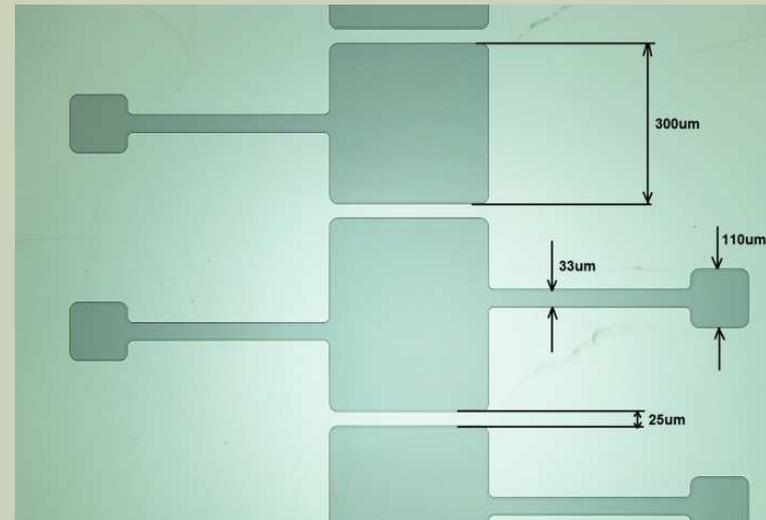
- ✓ Negative, photo-patternable thermal cure adhesive
- ✓ Very good adhesion to Silicon and glass
- ✓ Film thickness 1 μ m to >25 μ m available
- ✓ Low temperature processing <200 °C
- ✓ High quality, void free bonding
- ✓ Applications: microfluidic and optical devices, WLP, capping of BAW and SAW devices

WHAT WE WANTED TO LEARN

- 1. Application and photolithography process**
- 2. Bonding process (curing temperature, time and bonding pressure)**
- 3. Alignment accuracy**
- 4. Bond quality**
- 5. Bond line width spread/broadening**
- 6. Bond strength**

1. APPLICATION AND PHOTOLITHOGRAPHY

- ✓ Applied by spinning
- ✓ Good pattern definition for wide range of exposure time - wide process window
- ✓ No adhesion promoter needed
- ✓ ~6 μ m thick layer obtained for PermiNex 1005



2. BONDING PROCESS

- ✓ Coating on one wafer only
- ✓ Wafers bonded up to a week after patterning
- ✓ Bonded in AML Aligner Wafer Bonder
- ✓ Chamber pressure $<1e-4$ mbar (recommended <0.1 mbar)
- ✓ Curing at 150°C for 1min - 5min
- ✓ Bonding pressure 1.8MPa - 2.5MPa (min recommended pressure is 0.58MPa)

BONDING STEPS

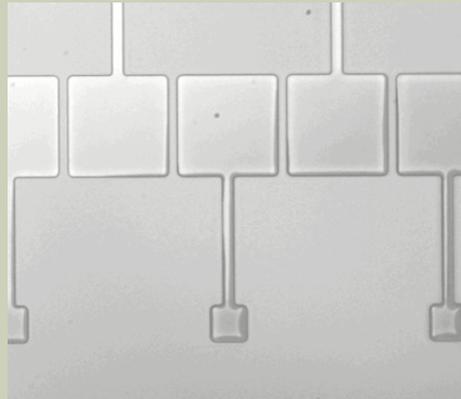
1. Load the wafers into the chamber
2. Pump down to $<1e-4$ mbar
3. Pre-align wafers
4. Start heating to 150°C with ramp rate $10^{\circ}\text{C}/\text{min} - 40^{\circ}\text{C}/\text{min}$
5. Align and contact wafers at $\leq 70^{\circ}\text{C}$ 15 - 20min
6. Apply full bonding force and continue heating to 150°C
7. When at 150°C , dwell for 1min - 5min
8. Vent the chamber and remove the wafers
9. For maximum bond strength hard bake in an oven at 180°C for 1 hour



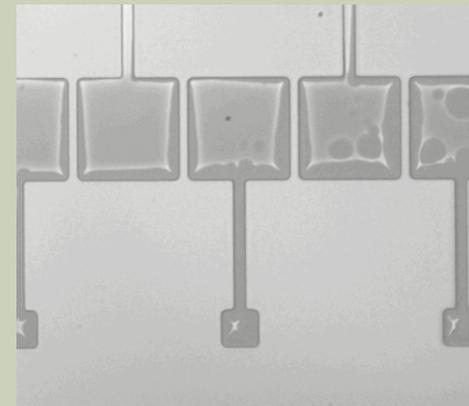
DURING BONDING...

Bond formation shown live through AML optical system

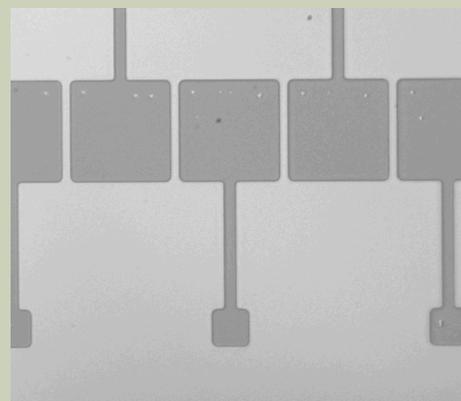
90 ° C



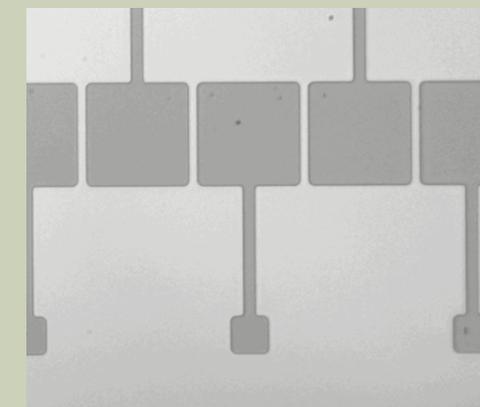
95 ° C



100 ° C



150 ° C

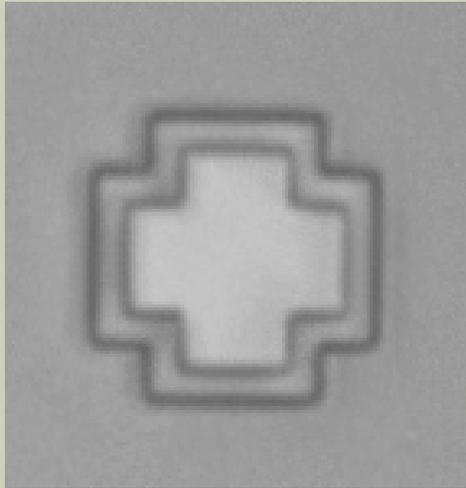


VIDEO...

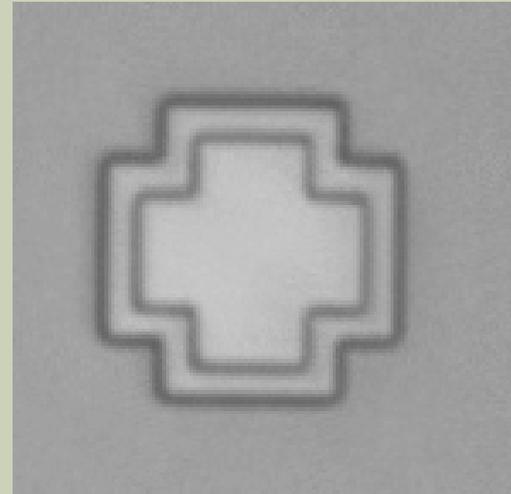
Hope it works...

3. ALIGNMENT ACCURACY – DURING BONDING

Alignment just before contact



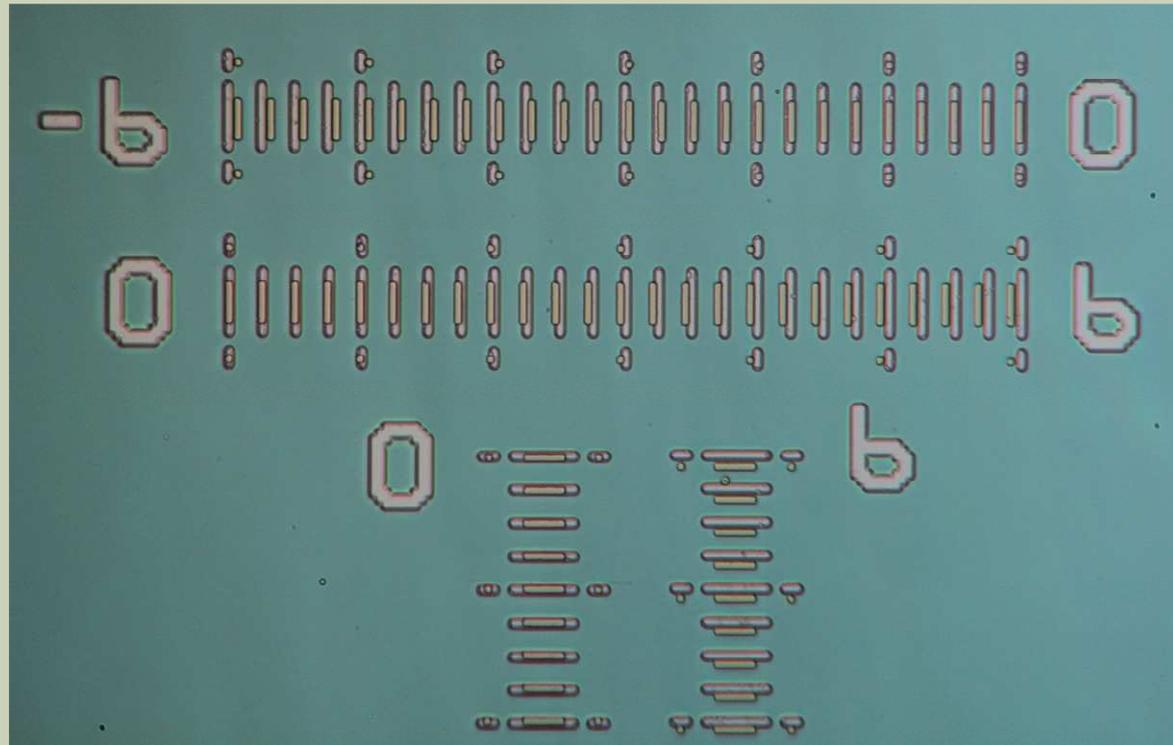
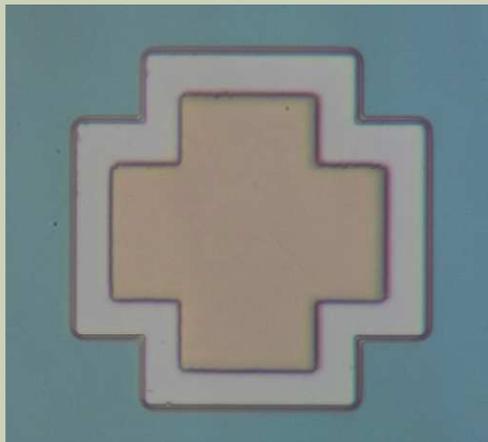
Alignment at 200N force



No contact shift observed

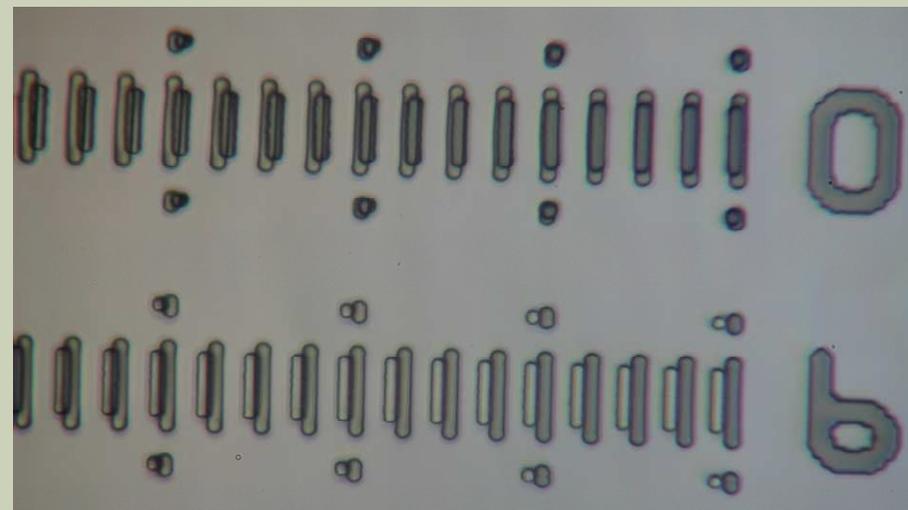
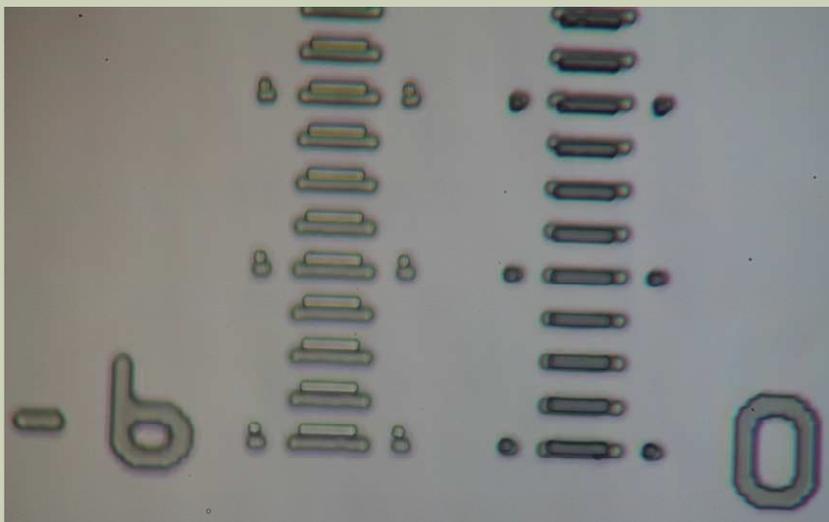
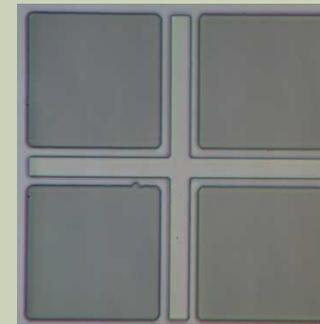
ALIGNMENT ACCURACY – POST BOND 1

- ✓ Post bond alignment accuracy of $\leq 1 \mu\text{m}$ measured under a microscope for PermiNex on glass – Si bonding (marks defined in metal)



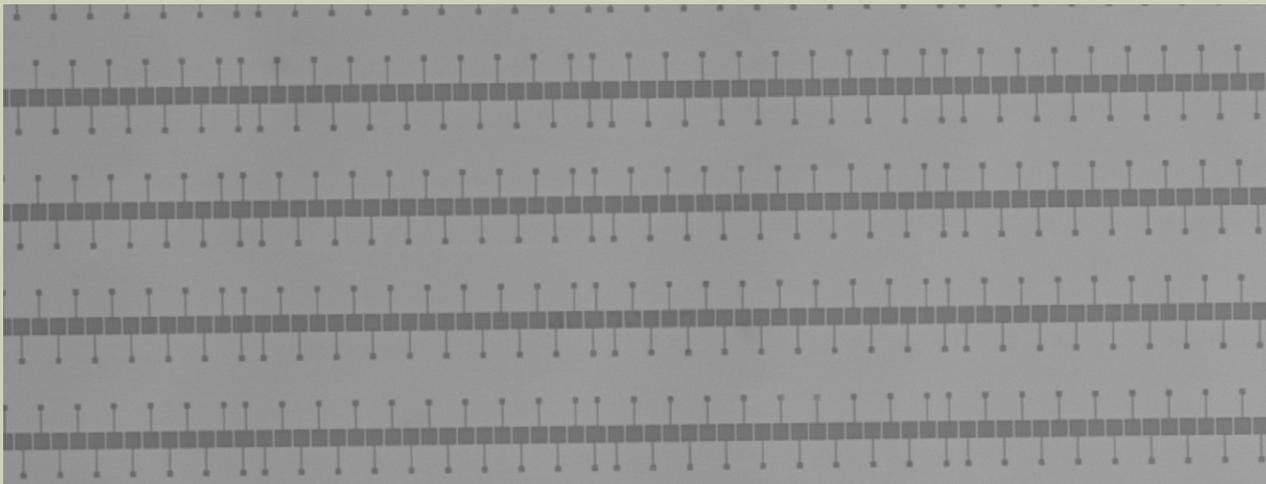
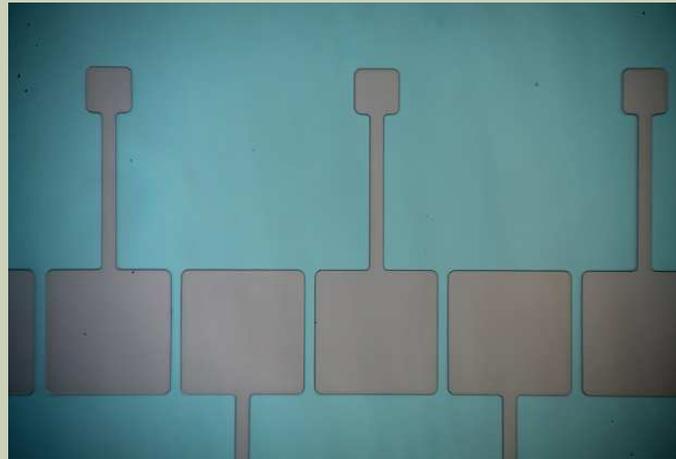
ALIGNMENT ACCURACY – POST BOND 2

- ✓ Post bond alignment accuracy of $\leq 1 \mu\text{m}$ measured under a microscope for PermiNex on glass – PermiNex on Si bonding (marks defined in PermiNex)



4. BOND QUALITY

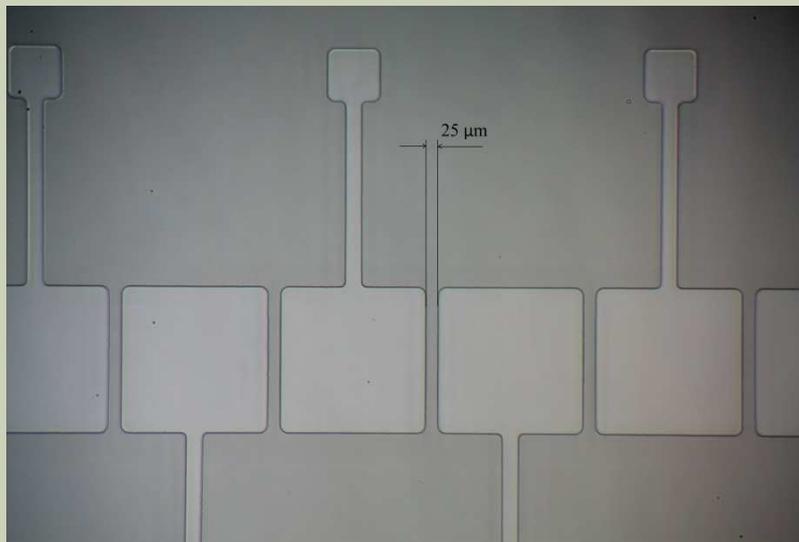
Microscope image



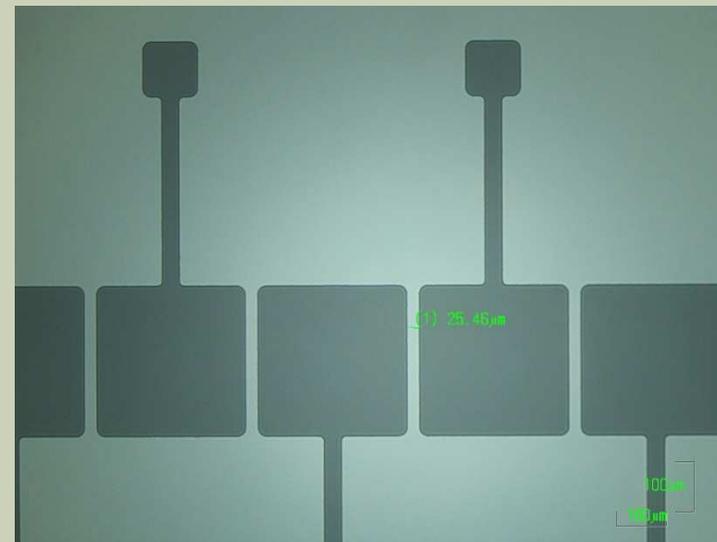
SAM image

5. BOND LINE WIDTH BROADENING

Pattern dimensions
before bonding



Pattern dimensions
after bonding



No visible bond line spread

6. BOND STRENGTH

- ✓ Attempted to measure the bond strength on a glass-Si pair using our new Maszara testing tool
- ✓ While inserting the blade, the wafers fractured before the bond was broken - this suggest a very strong bond, not possible to measure

SUMMARY AND ADVANTAGES

- ✓ PermiNex bonding was tested on glass, plain Si and Si oxidised wafers
- ✓ Bonded PermiNex to bare wafer and PermiNex to PermiNex
- ✓ Reliable and relatively simple lithography process, wafers patterned up to a week ahead of bonding
- ✓ Only one wafer of a pair requires coating
- ✓ $\leq 1 \mu\text{m}$ post bond alignment accuracy achieved - no sliding or contact shift observed
- ✓ No flow and no bond line spread while curing
- ✓ Fast curing - significantly reduced bond cycle
- ✓ Good quality and high strength bonding



ANY QUESTIONS?



**THANK YOU FOR YOUR
ATTENTION...**



**...AND ENJOY YOUR
COFFEE BREAK!**

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AML

