PERMANENT BONDING ADHESIVE

A Novel Permanent Boding Material

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brewer science

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  - Material adhesion
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INTRODUCTION – PERMANENT BONDING

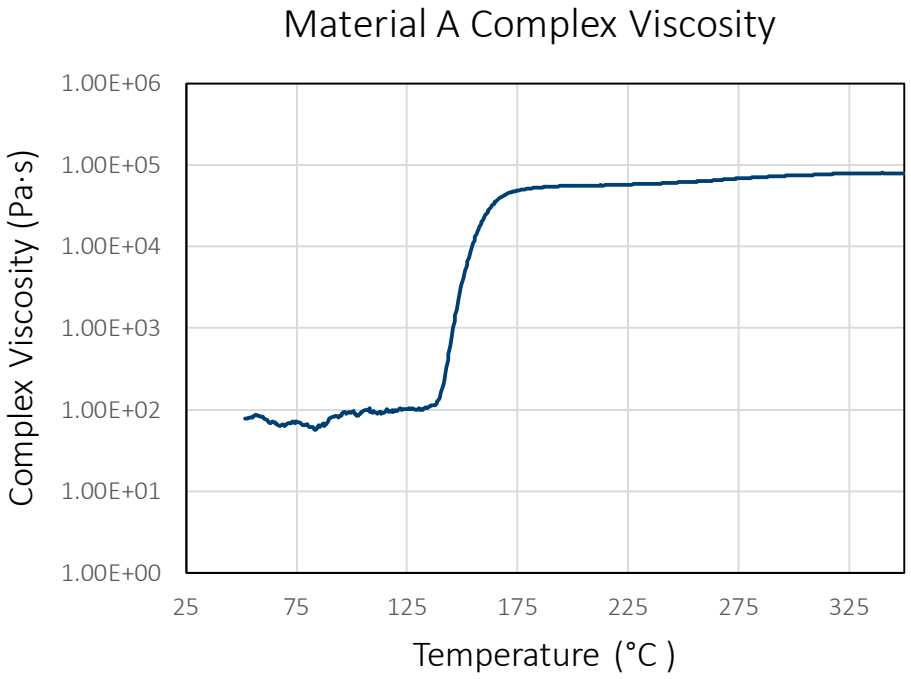
- Permanent bonding adhesives:
  - Simple to apply to a substrate with spin coating techniques
  - Can be thermocompression bonded
  - Adhere strongly to a variety of substrates
  - Have high thermostability
  - Maintain resistance to various chemicals and solvents
- Material A, evaluated by Brewer Science:
  - Can be spin coated onto a variety of substrates
  - Can be thermocompression bonded at low temperature (60°C), enabling high throughput
  - Has good adhesion to silicon, glass, copper, silicon nitride, and Kapton® film
  - Is thermally stable up to 300°C
  - Is resistant to many common solvents and processing chemicals

PROPERTIES

Rheology, mechanical and thermal properties, n and k and dielectric properties

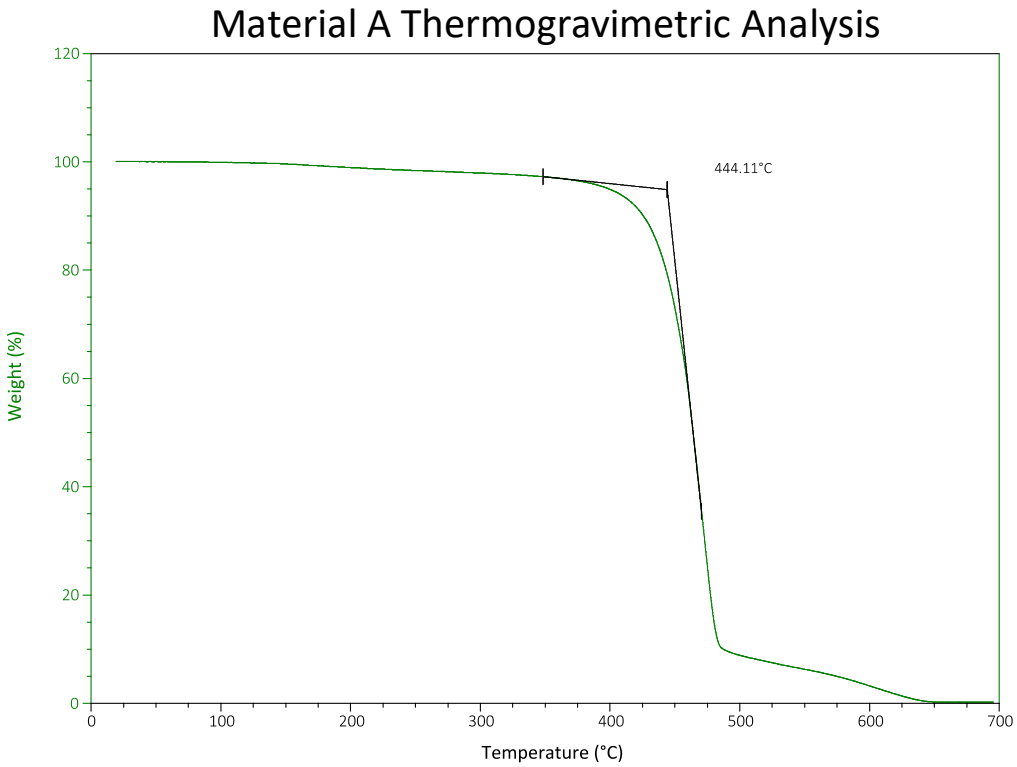
THERMOMECHANICAL MATERIAL PROPERTIES

Property	Result
Tg (DSC)	< 5°C
Tg cured (DSC)	41°C
Td (TGA)	300°C
Viscosity (Bookfield)	35 cP at 37.8°C
Viscosity (Bookfield)	45 cP at 25°C

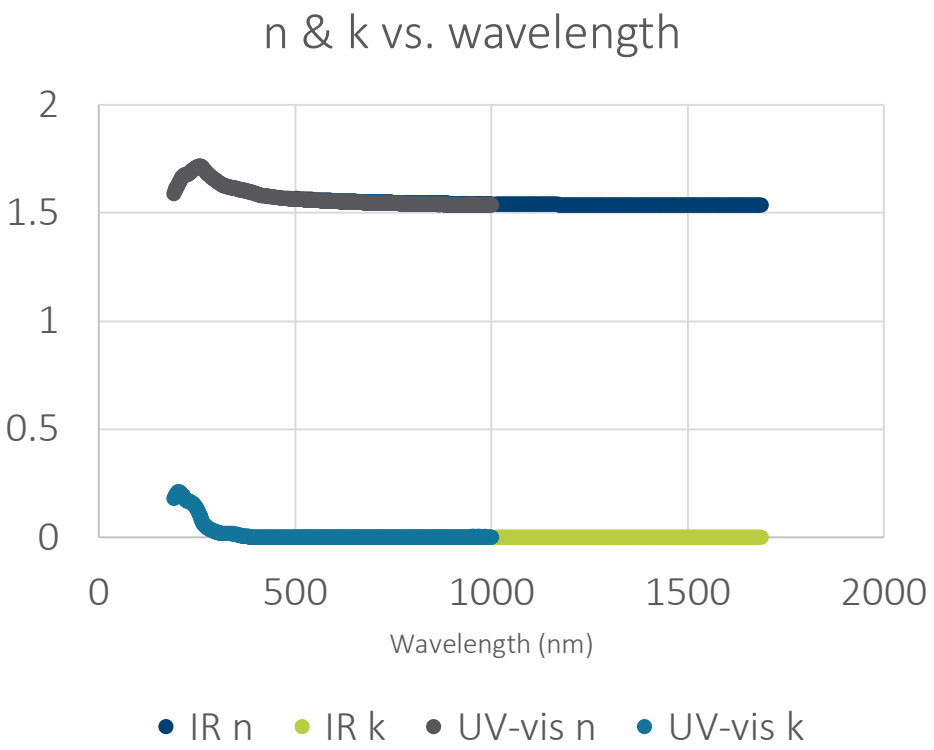


THERMOMECHANICAL MATERIAL PROPERTIES

Property	Result
Tensile strength	38.5 MPa
Elongation	50%
Modulus	1.0 GPa
Weight loss at 300°C (TGA)	3-5%
Dielectric constant	2.52



OPTICAL MATERIAL PROPERTIES

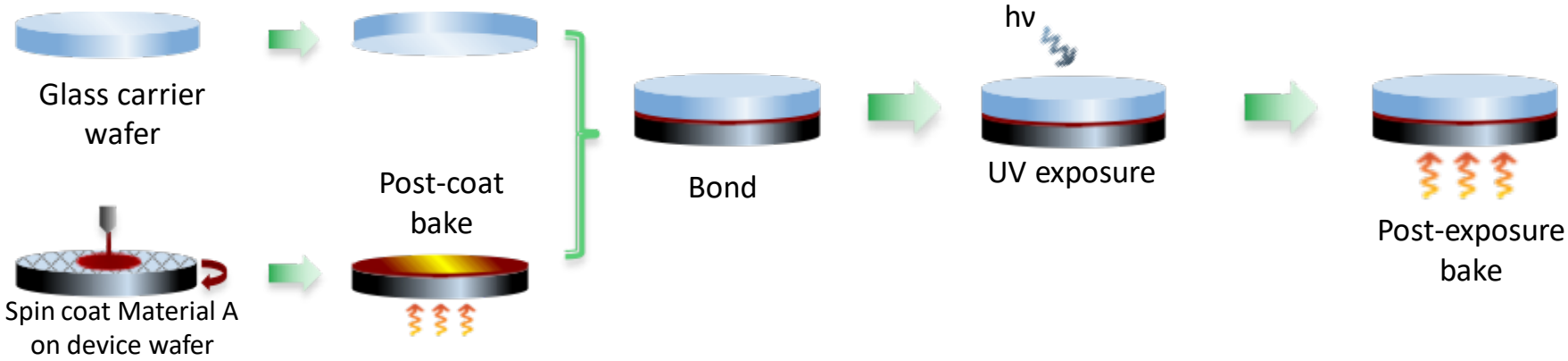


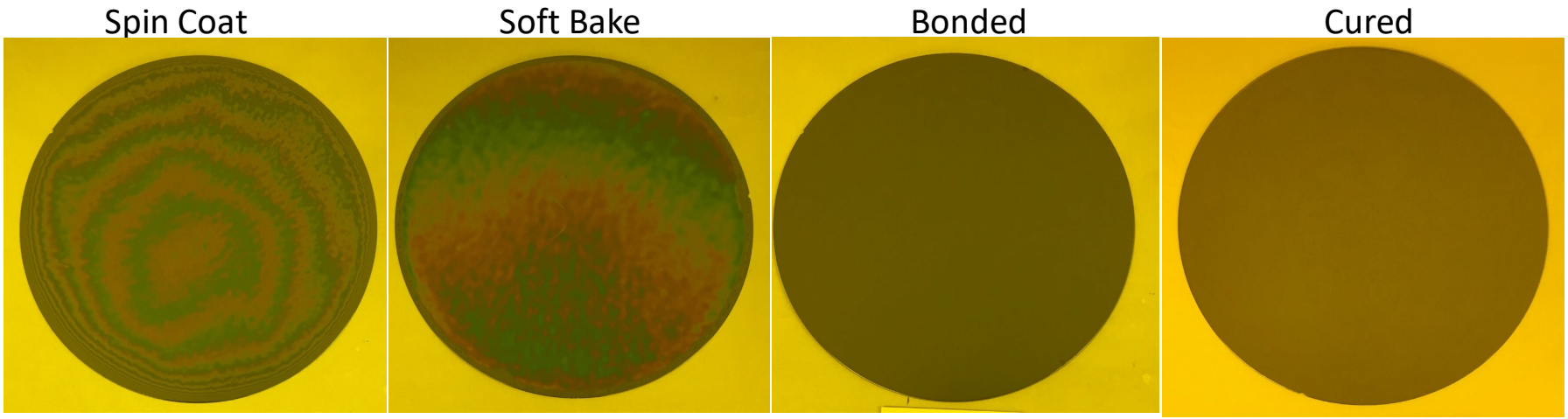
Wavelength (nm)	Refractive Index	Extinction Coefficient
248	1.72	0.13
365	1.61	0.01
633	1.55	0.00

PROCESS CONDITIONS

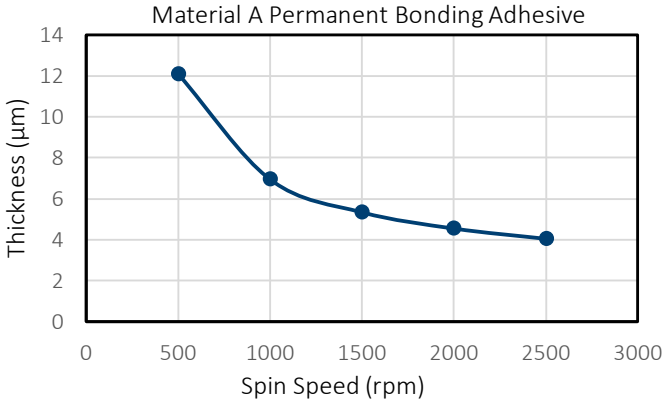
Spin Coat, bond and cure processes

BOND SCHEME AND PROCESS FLOW





SPIN SPEED CURVE, BOND AND CURE PROCESS



Bonding Process	
Temperature	60°C
Time	3 min
Vacuum	< 5 mbar
Force	2000 N

Acceleration	1500 rpm/sec
Spin Time	30 sec

Cure Process	UV Cure Time	Cure Temp, Time 1	Cure Temp, Time 2	Thickness Loss
1	-	230°C, 30 min	-	1.58%
2	-	230°C, 10 min	250°C, 50 min	1.69%
3	-	220°C, 10 min	250°C, 50 min	2.80%
4	2 min	220°C, 5 min	250°C, 5 min	0%
5	4 min	-	-	0.36%

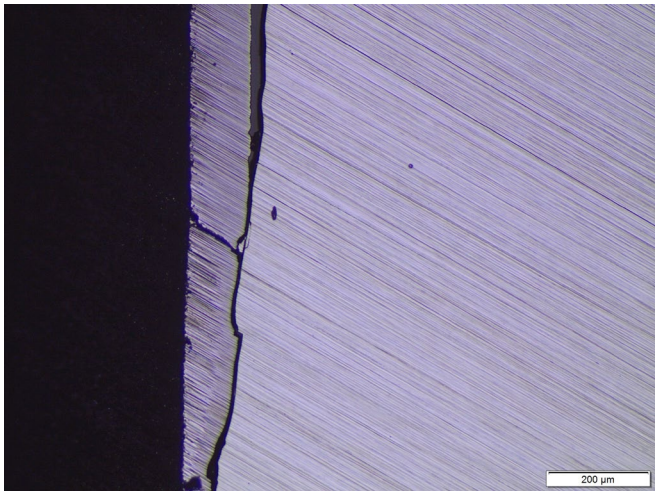
RESULTS

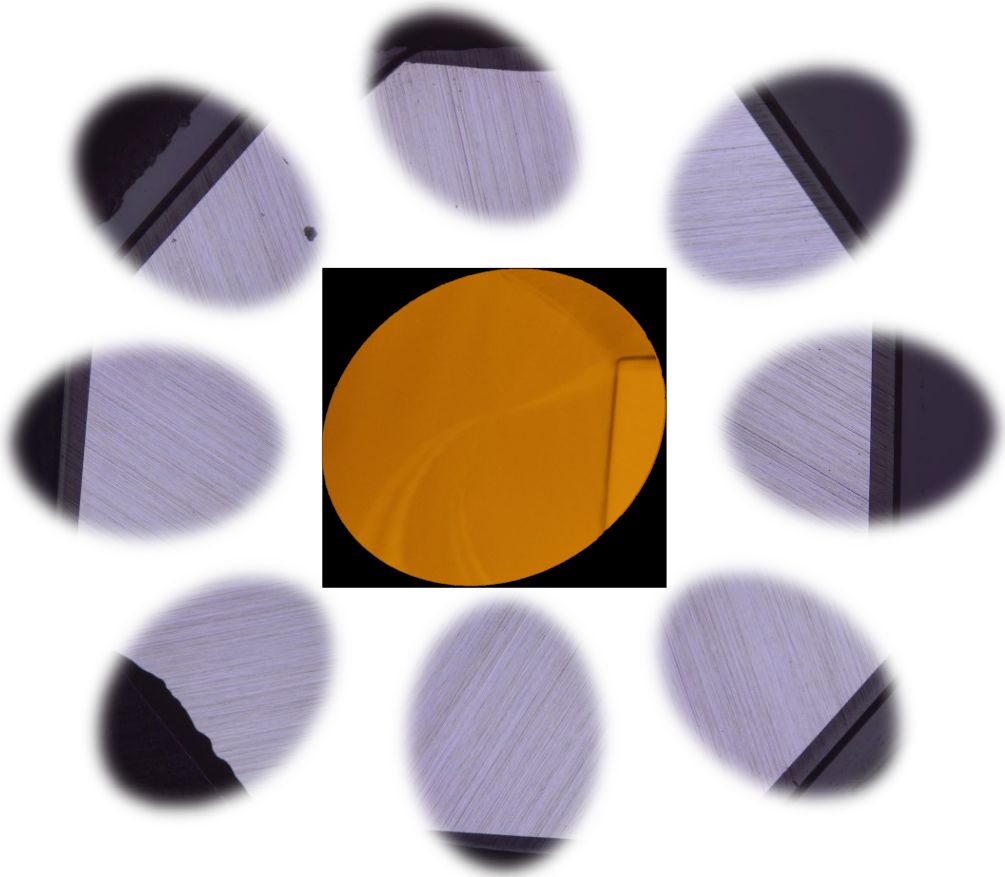
Backside grinding; stress, bow and warp; etch rate; material adhesion; chemical resistance

BACKSIDE-GRINDING

- Backside grinding to 15 µm
  - Mechanical grinding & wet etching
  - Also successfully evaluated at 20 & 30 µm
  - Double-side polished, edge trimmed 200 mm Si wafer
- Bond integrity was maintained
  - Chipping was localized, not systemic
  - Largest chips were ~100 µm from the edge
  - No cracks observed in the silicon substrate

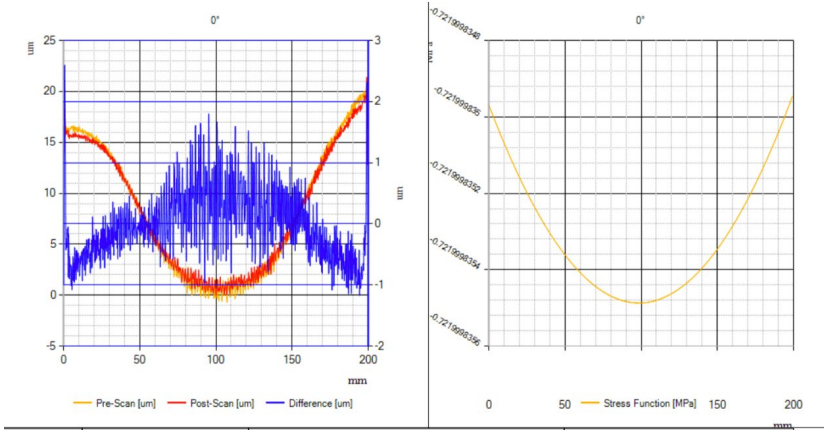
Worst spot: 8 o'clock



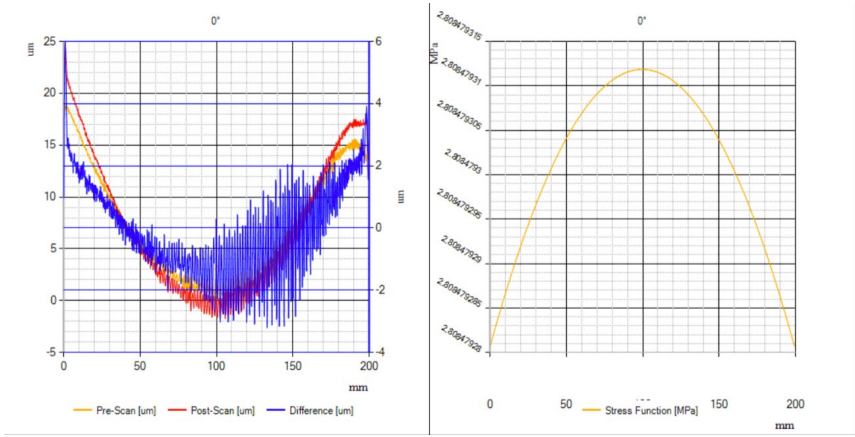


STRESS TESTING

Material A	Warp (µm)	Bow (µm)	Stress (MPa)
Soft bake	26.89	14.71	0.274
Cured	26.61	15.53	2.414
Difference	-0.28	0.82	2.14



Soft bake



Cured

ETCH RATE

Edge Exclusion (EE)	Pre-etch (µm)	DC Bias (V)	Etch time (sec)	Post-etch (µm)	Etch Rate (nm/sec)
Line 0mm EE	5.918	311	10	5.915	0.3
Line 3mm EE	5.867	311	10	5.845	2.2
Map 3mm EE	5.985	311	10	6.022	-3.7
Line 0mm EE	5.811	311	20	5.782	1.5
Line 3mm EE	5.764	311	20	5.73	1.7
Map 3mmEE	5.899	311	20	5.903	-0.2
Line 0mm EE	5.934	312	30	5.855	2.6
Line 3mm EE	5.894	312	30	5.829	2.2
Map 3mmEE	5.961	312	30	5.957	0.1
Line 0mm EE	5.793	317	60	5.697	1.6
Line 3mm EE	5.753	317	60	5.634	2.0
Map 3mm EE	5.863	317	60	5.777	1.4
Line 0mm EE	**5.915**	**315**	**300**	**5.271**	**2.1**
Line 3mm EE	**5.845**	**315**	**300**	**5.199**	**2.2**
Map 3mm EE	**6.022**	**315**	**300**	**5.358**	**2.2**
Line 0mm EE	**5.782**	**311**	**600**	**4.546**	**2.1**
Line 3mm EE	**5.73**	**311**	**600**	**4.473**	**2.1**
Map 3mmEE	**5.903**	**311**	**600**	**4.659**	**2.1**

- Etch Rate: 2.1 nm/sec
- Gas: O_2
- Flow (sccm): 30
- Power (W): 100
- FRT thickness had too much error during short etch times
- For longer etch times, etch rate converged

ADHESION

- PosiTest adhesion pull-off tester
- ASTM D4541 compliant

Substrate	Bond Force (psi)
Glass	40.2
Si	54.8
Cu	24.4
SiN	42.0
Kapton	54.2

CHEMICAL RESISTANCE TEST

Chemical	Bath Temp.	Soak Time	Film	Bond Line (Bonded to Glass Wafer)
H_2SO_4 (16%) + H_3PO_4 (16%) + HF (2.75%)	25°C	30 min	Pass	Pass
HNO_3 (40%)	50°C	30 min	Pass	Pass
HF (1%)	25°C	90 min	Pass	Pass
H_2O_2 (30%)	55°C	30 min	Pass	Pass
PGMEA	25°C	30 min	Pass	Pass
Cyclopentanone	25°C	10 min	Pass	Pass
Isopropanol	25°C	30 min	Pass	Pass
Acetone	25°C	25 min	Pass	Pass
Ethyl Lactate	25°C	30 min	Pass	Pass
EKC	60°C	20 min	Pass	Pass
P1331	60°C	20 min	Fail	Pass
40% KOH	80°C	30 min	Fail	Pass

CONCLUSIONS – PERMANENT BONDING ADHESIVE

- Material A exhibits:
  - Good resistance to standard process solvents and chemicals
  - High adhesion to a variety of substrates
  - Good thermal stability
  - Low bonding temperature
  - Short curing time
- Material A is an opportunity for high-throughput manufacturing in various permanent bonding applications

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