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Printable Board-on-Chip (PBOC) Adhesives for DRAM Applications

Training Material, August 2008

TRAINING OUTLINE

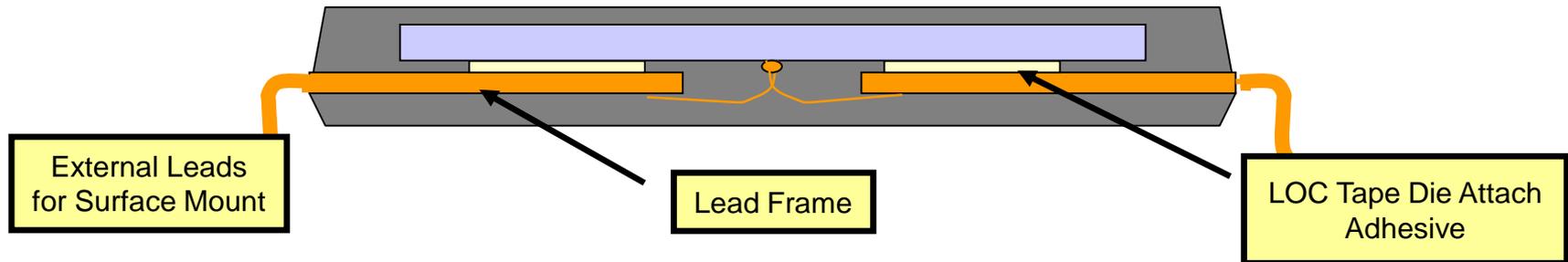


- Background – Packages and Materials Roadmap
- PBOC Application Process Overview
 - 6202C Processing
 - 6202C Failure Analysis
 - Additional Information

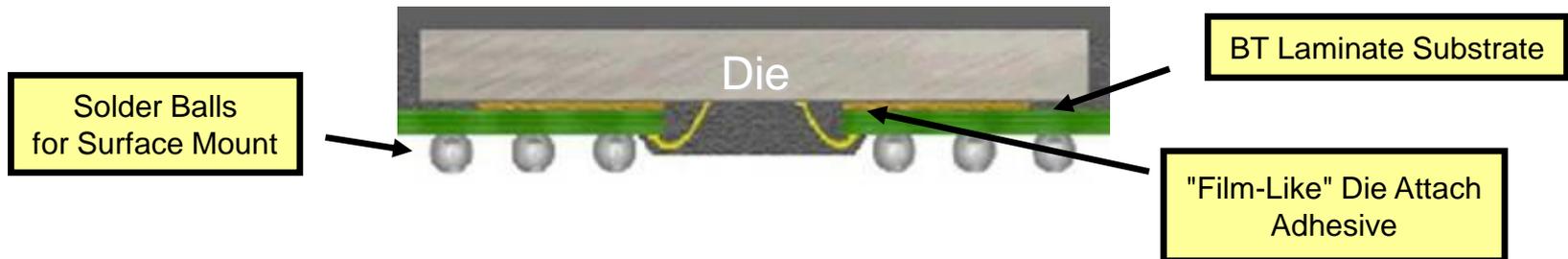
BACKGROUND: DRAM PACKAGES



LOC (Lead on Chip) TSOP Package used for Standard DRAM



BOC (Board on Chip) Type FBGA Package used for DDR II (high speed) DRAM



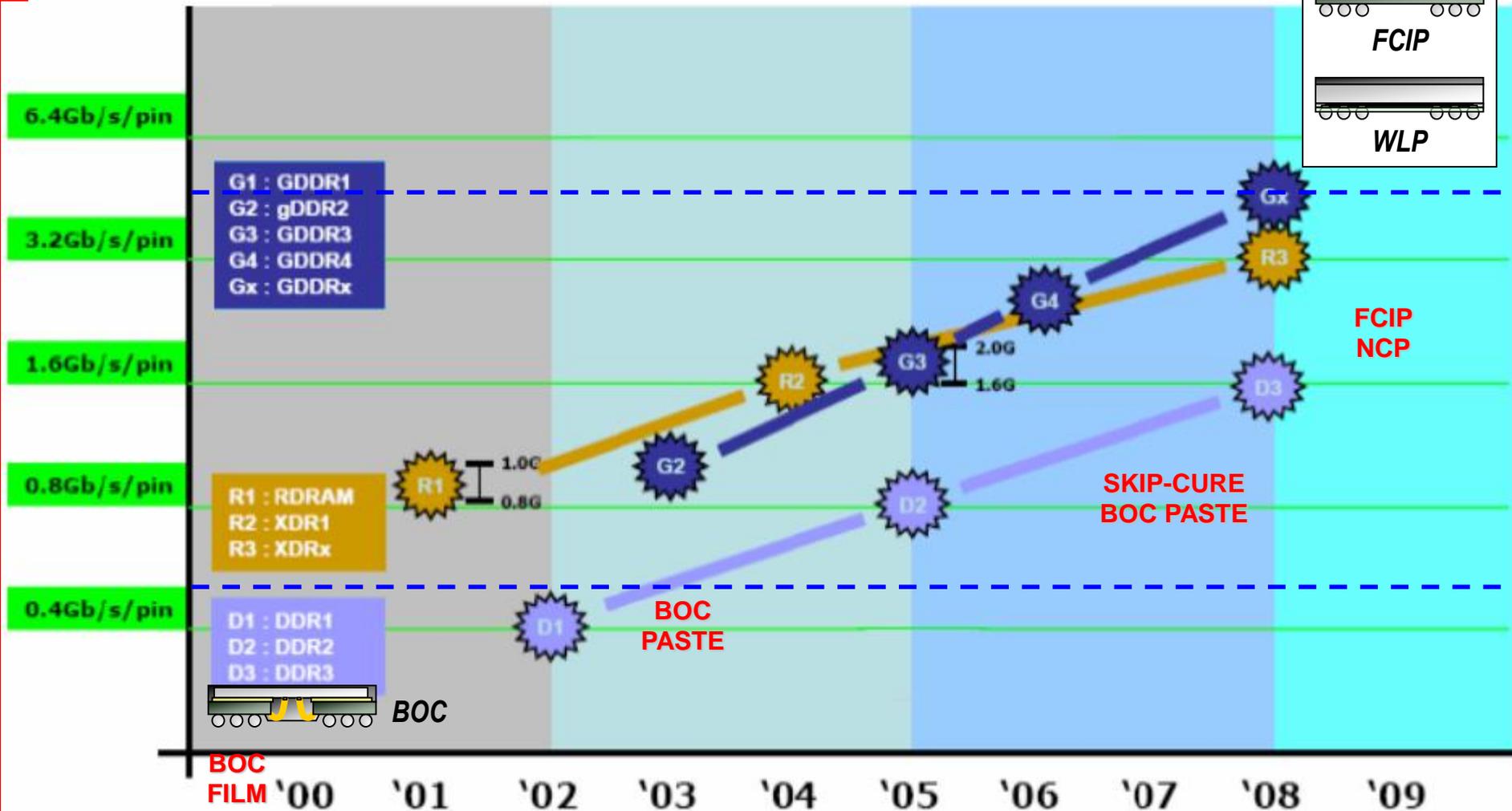
Example of a CSP (Chip Scale Package):

60% less volume, 70% less weight, 30% less power, and 60% higher speed

DRAM PACKAGING TREND & MATERIALS

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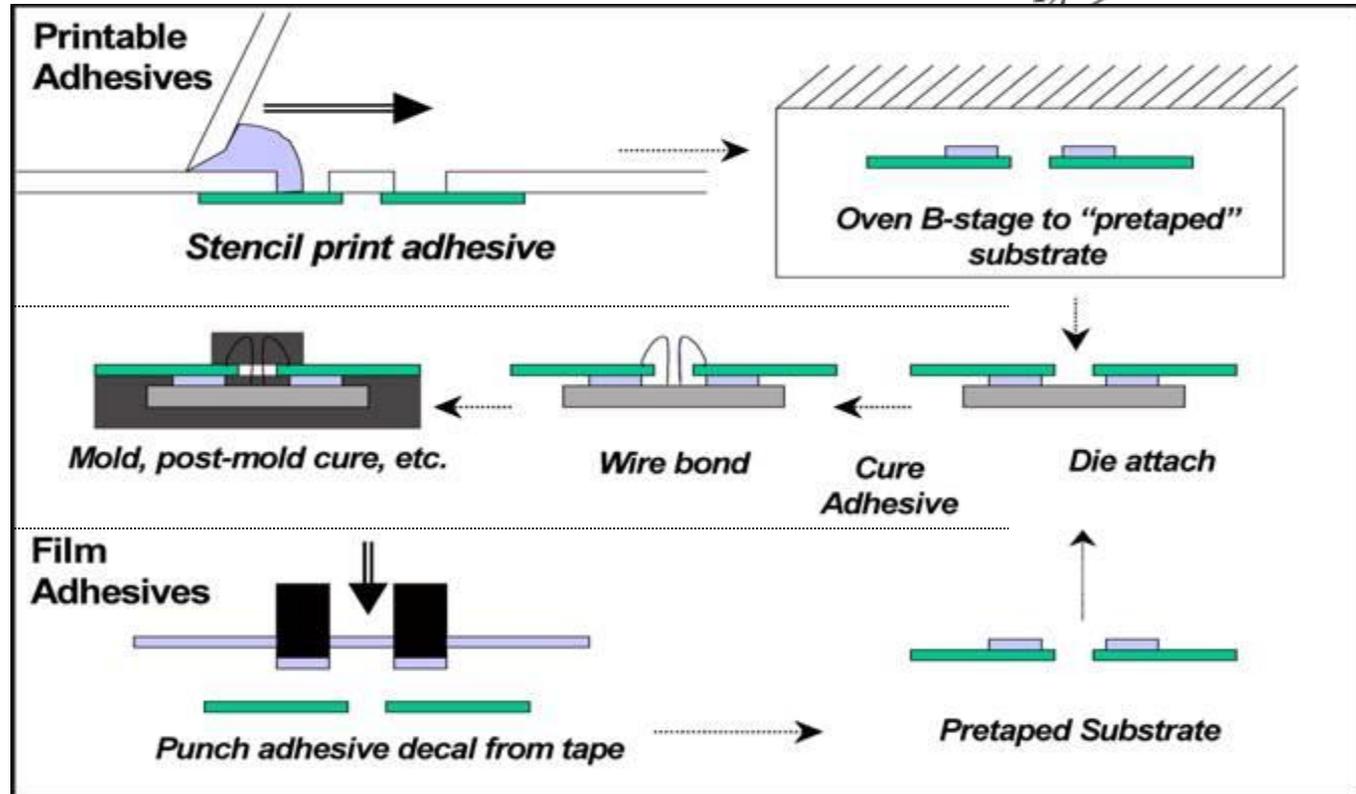


BACKGROUND: PRINTABLE VERSUS FILM

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pBOC

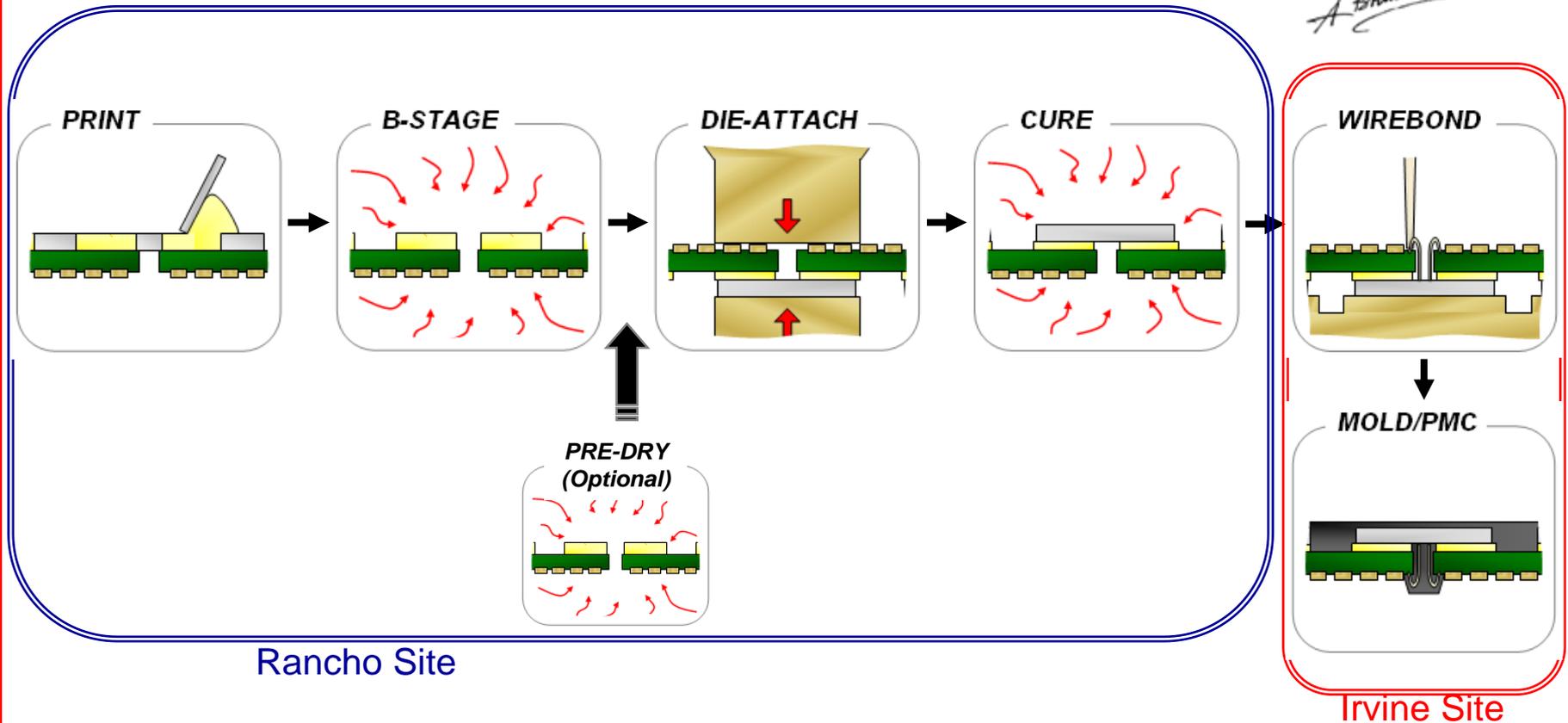


LOC



Printable Adhesives provide a low cost solution compared with film adhesives

BOC PROCESS OVERVIEW



Rancho & Irvine together have the capabilities for end-to-end PBOC processing

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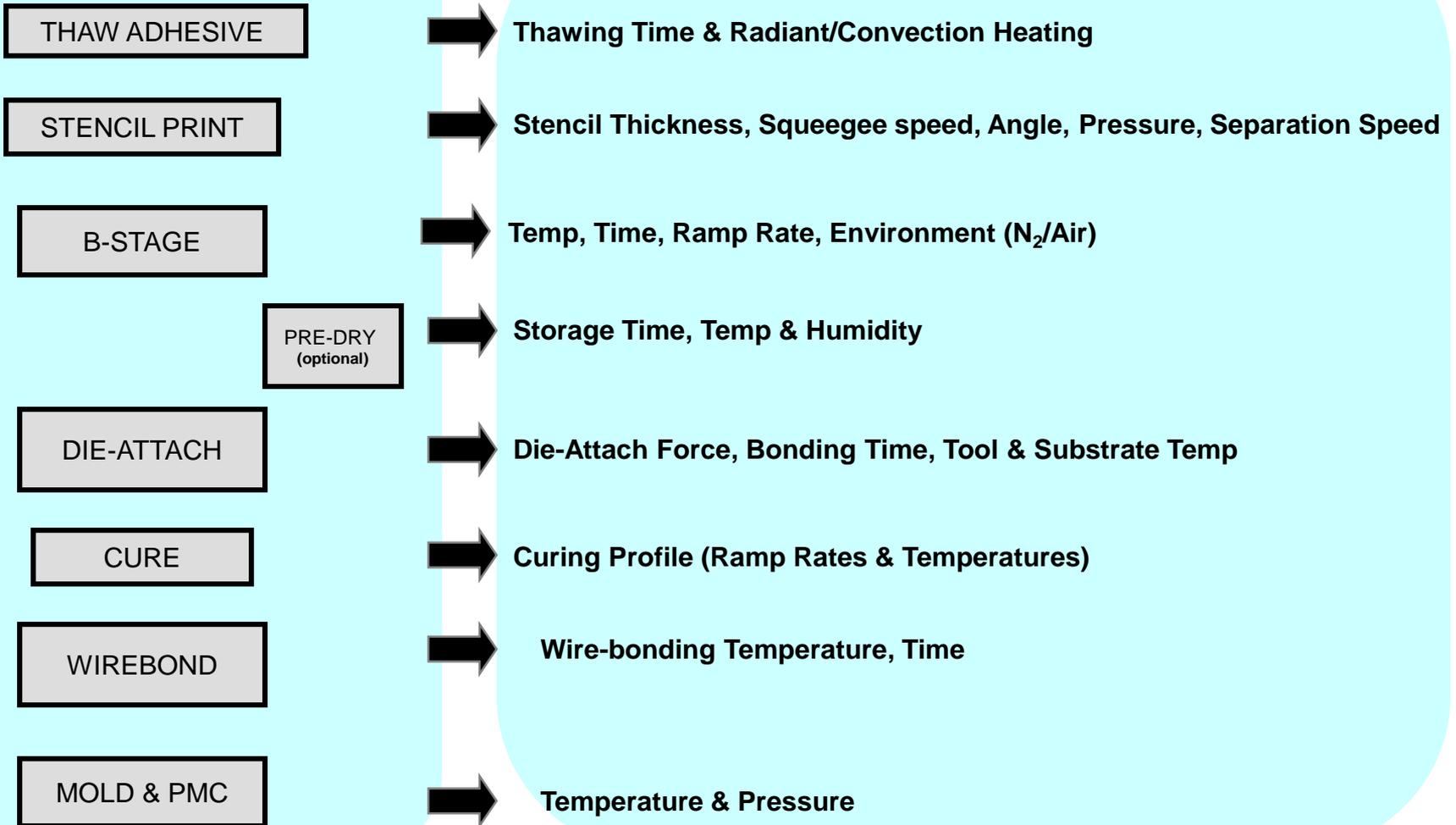
**PBOC APPLICATION PROCESS
with 6202C**

APPLICATION PROCESS with 6202C



APPLICATION STEPS

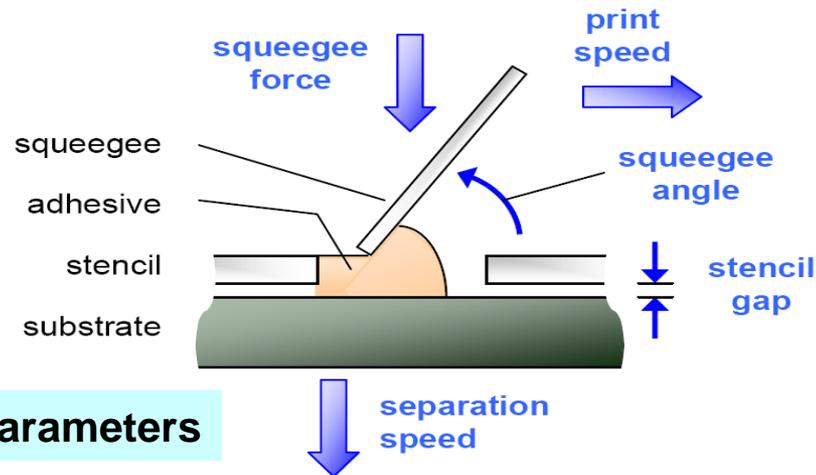
PROCESS FACTORS



6202C STENCIL PRINTING



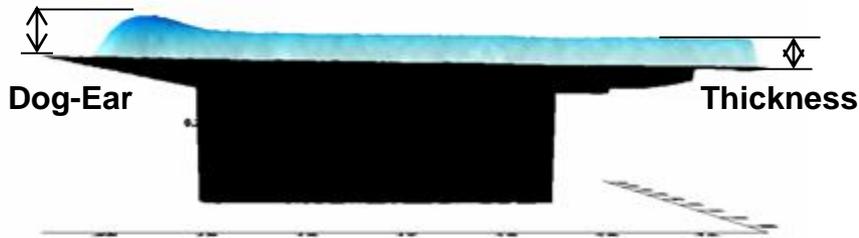
Bond Line Thickness primarily depends on Stencil thickness



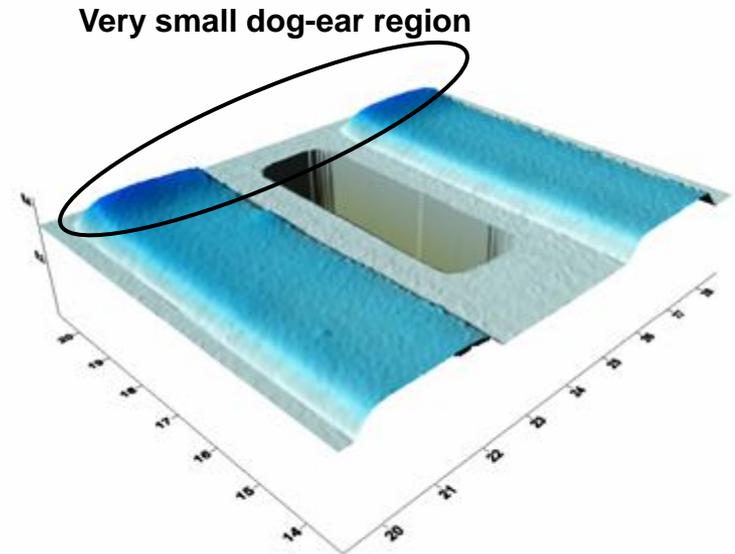
Recommended Parameters

Squeegee	Steel or Rubber (95-120 hardness), 60°/ 65°
Print Pressure:	4 – 6 kgf (8.8 – 13.2 lbs)
Print Speed:	20 – 70 mm/s
Dwell Height:	5 – 10 mm (not critical).
Dwell Speed:	10 mm/s (not critical).
Separation Speed:	3 mm/s
Stencil Wiping:	Printer specific (to be determined by the customer)
Print Gap:	'On contact'

6202C B-STAGED PRINT PROFILE



Very small Dog-Ear length



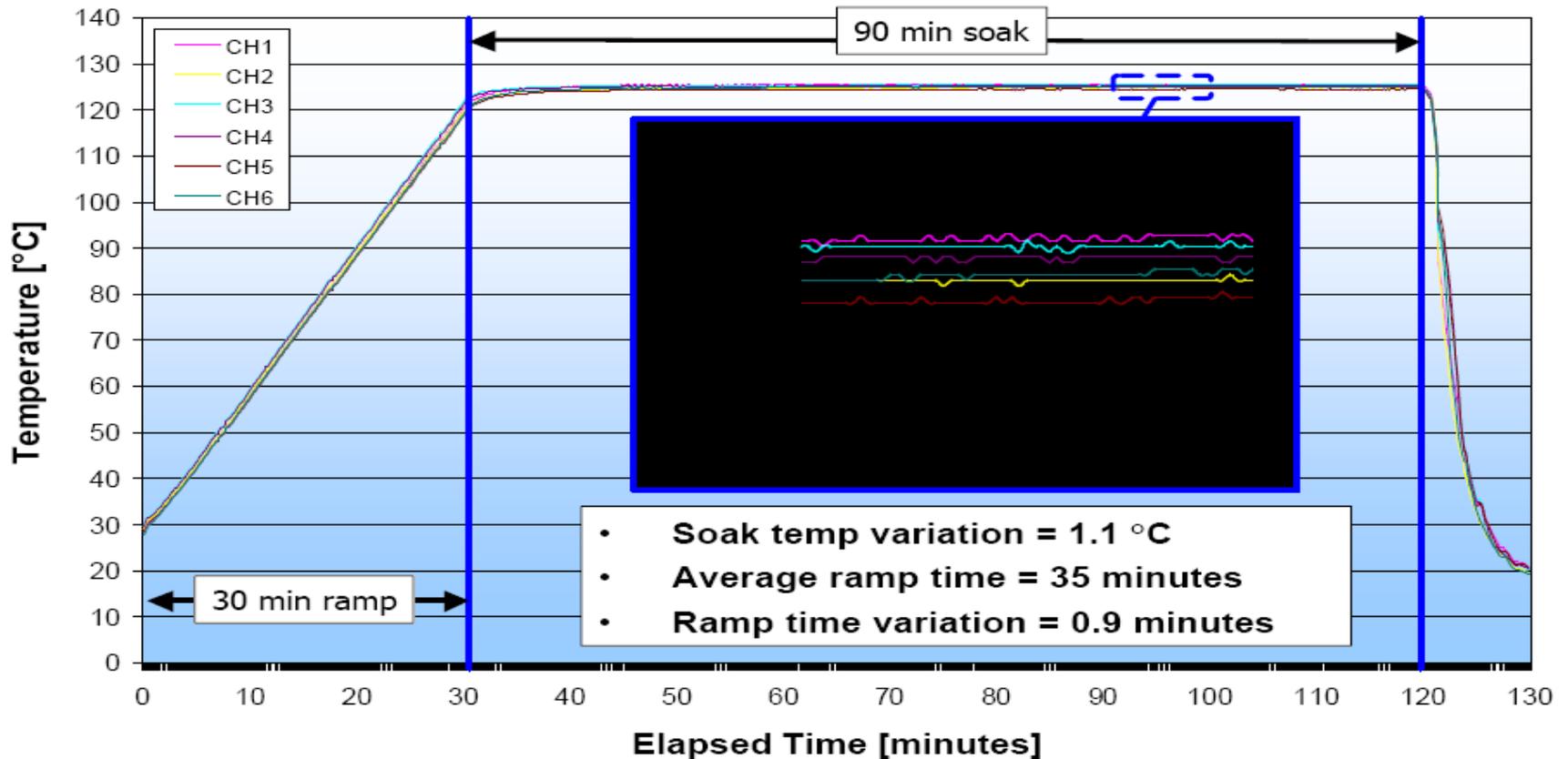
Smooth Topography

Property	Stencil Thickness	6202C
Average thickness	75um	32 um
	150um	52 um
Dog-ear height	75um	22 um
	150um	36 um

6202C B-STAGE PROFILE



B-Stage Oven Profile w/ Magazine and Ramp



☐ Recommended B-stage Condition: 125°C / 90min

6202C PRE-DRY



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- Pre-drying of parts just prior to die attach may be needed to prevent substrate moisture forming voids during cure

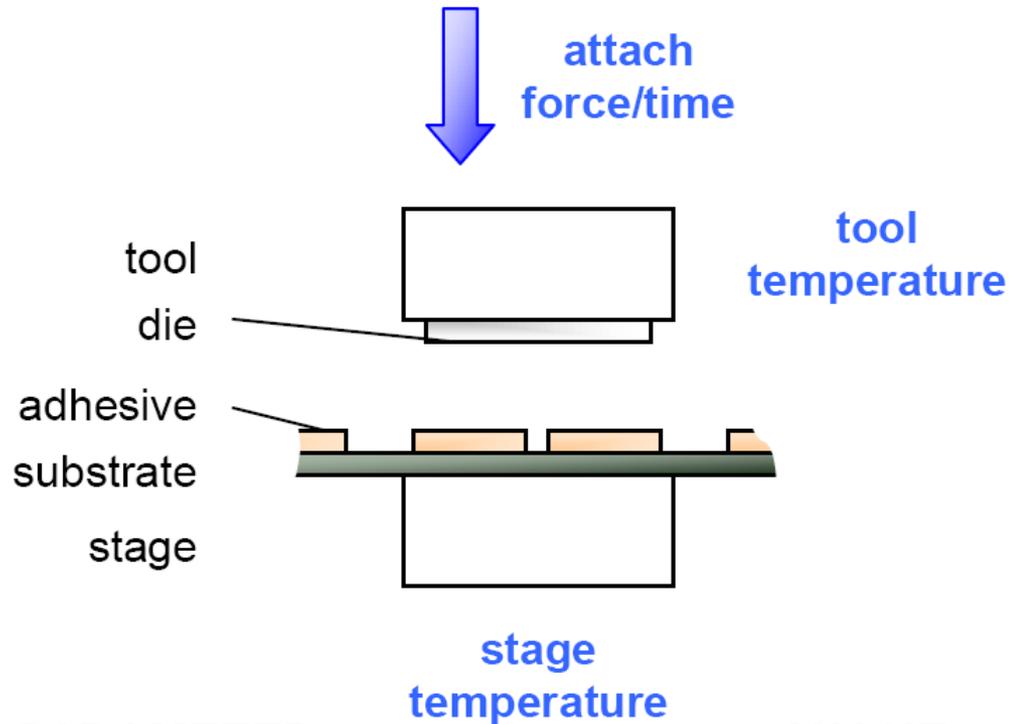
B-stage	125'C/60min	125'C/90min
No predry		
Predry		

Recommended Conditions:

B-Stage Condition	Storage Time (After B-Stage)	Pre-Dry Condition
90min / 125°C	<8 hrs	Not Needed
90min / 125°C	>8 hrs	5 min / 125°C

All above recommendations apply to “in-line” predry only (in predry chamber of die attach machine). For “off-line” predrying (batch oven), doubling the predry time is recommended.

6202C DIE-ATTACH

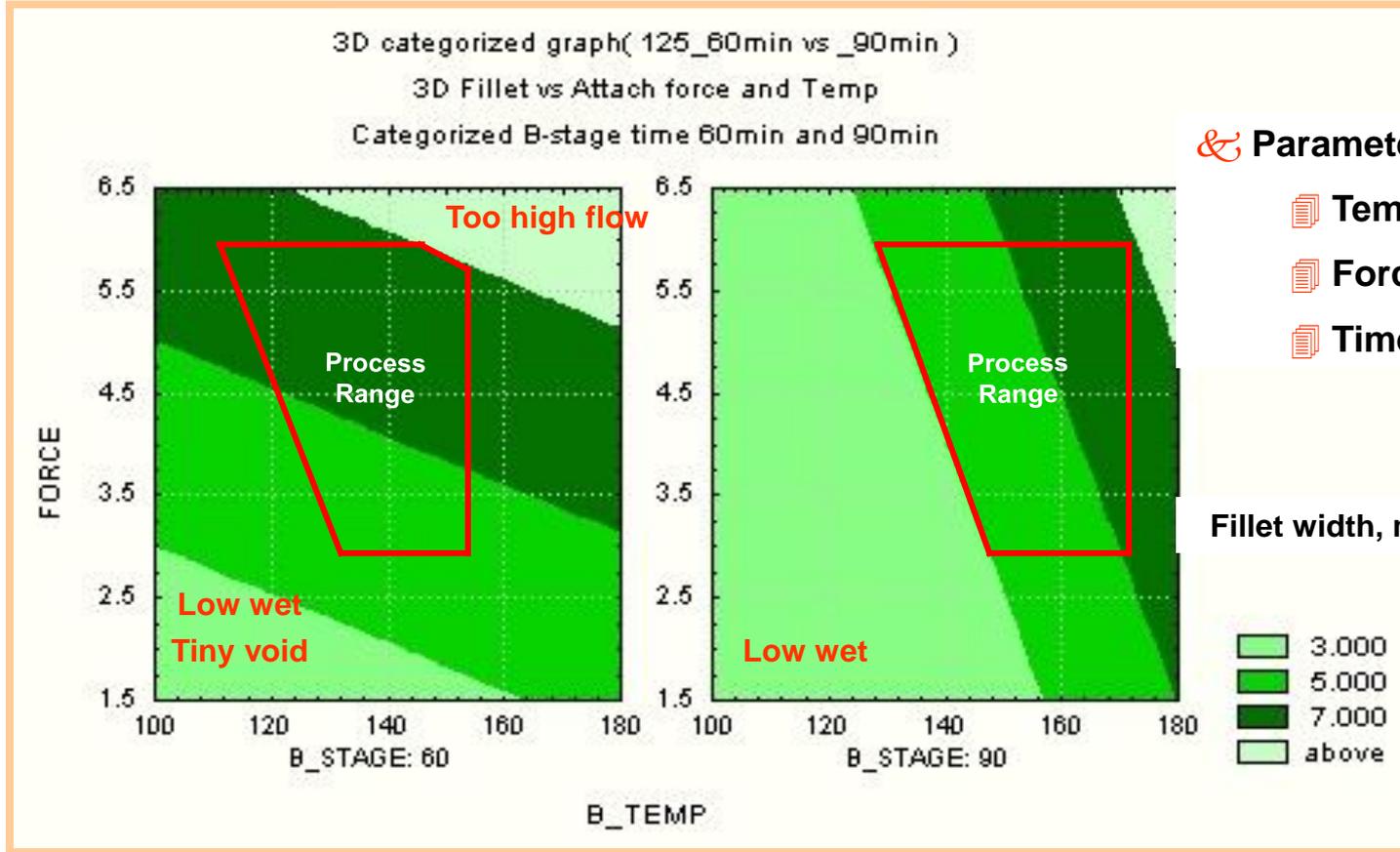


PARAMETER	VALUE
Die-Tool Temp	150°C
Substrate Temp	30°C
Die-Attach Force	50-80N
Die-Attach Time	0.3s - 0.5s
Die-Attach Area	50 mm ²

6202C DIE ATTACH PROCESS WINDOW



☐ Recommended B-stage Condition: 125°C / 90min with 30 min. Ramp



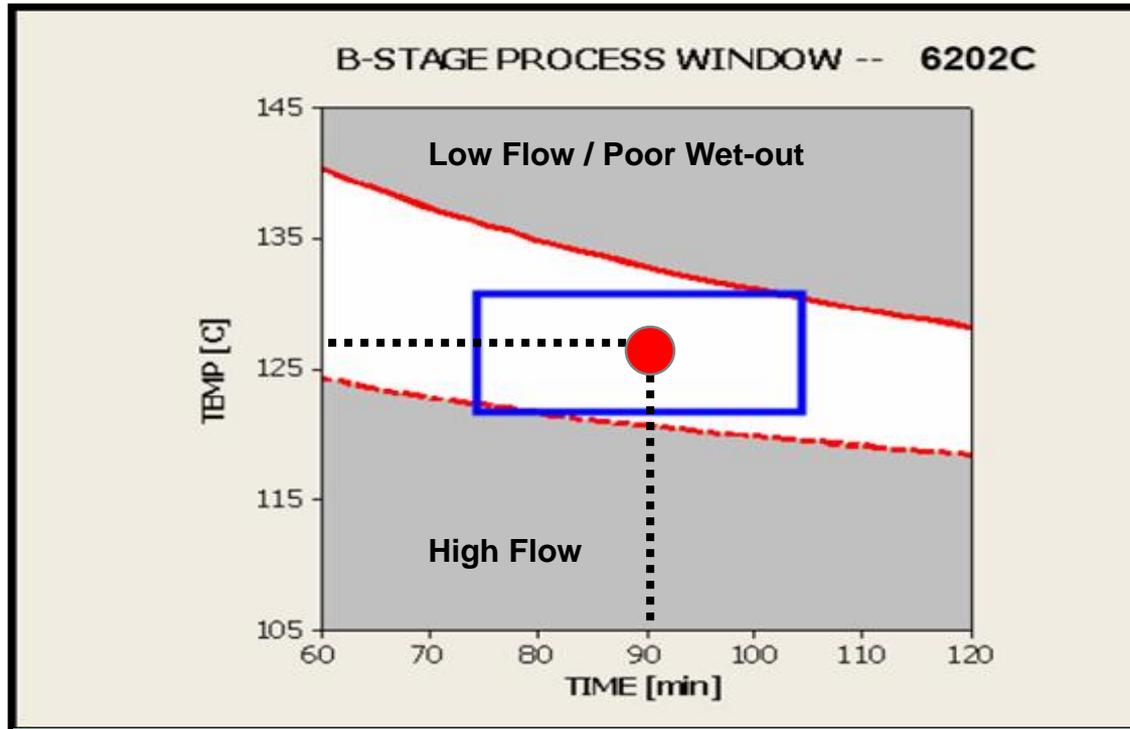
& Parameter range

- ☞ Temp : 110 ~ 160°C
- ☞ Force : 3 ~ 6 kg
- ☞ Time : 0.5-1 sec

☞ Bottom Temp is die side temp / Top Temp is substrate side

☞ Pre-dry condition : 125°C / 5min

6202C B-STAGE WINDOW (NO PRE-DRY)



❑ Recommended B-stage Condition: 125°C / 90min

- 6202C usually wets out the die very well
- But flow level is sensitive to temperatures above 125°C
- Large Time window – but <75 min. may be prone to voiding

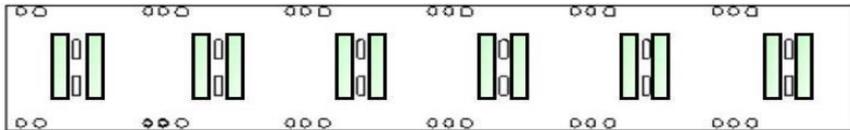
6202C FLOW TEST



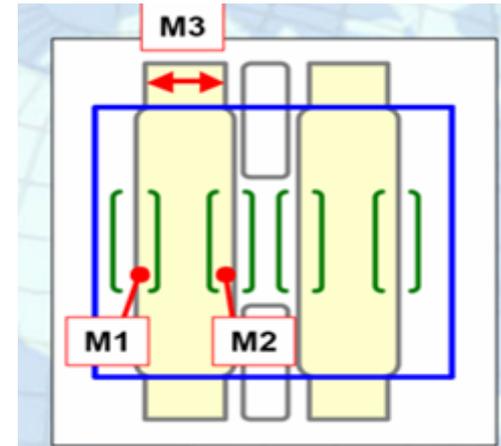
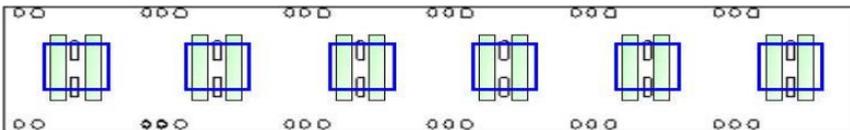
Flow Test enables quantification of adhesive flow during die-attach for

- Developing robust B-Stage window and die-attach conditions
- Testing batch-to-batch variation in the adhesive product

1. 6202C Printed & B-staged on BT substrate



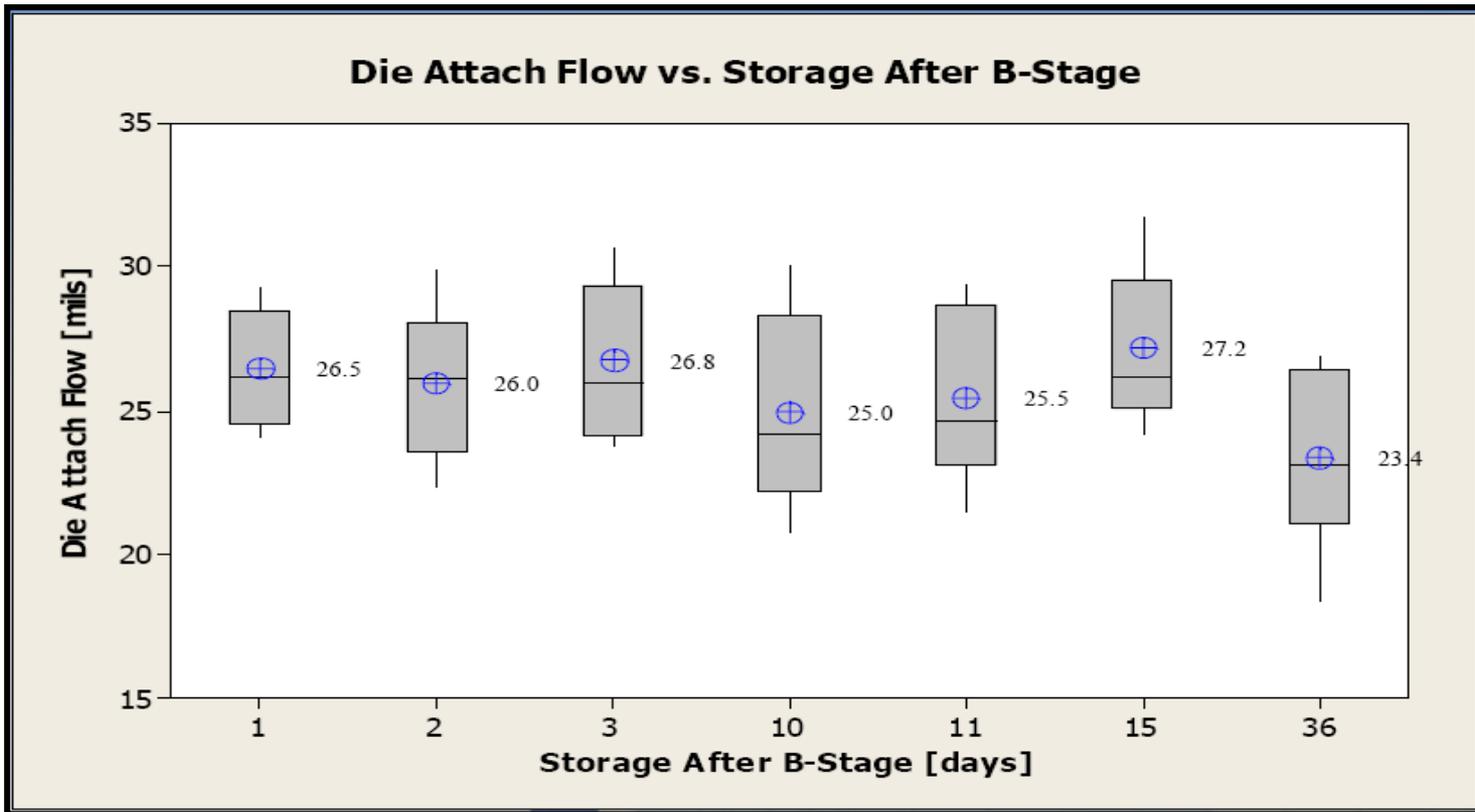
2. Die-Attach on printed pads



3. Measure Flow of the adhesive on both pads

$$\text{Flow} = ((M2 - M1) - M3) / 2$$

6202C STORAGE AFTER B-STAGE FLOW



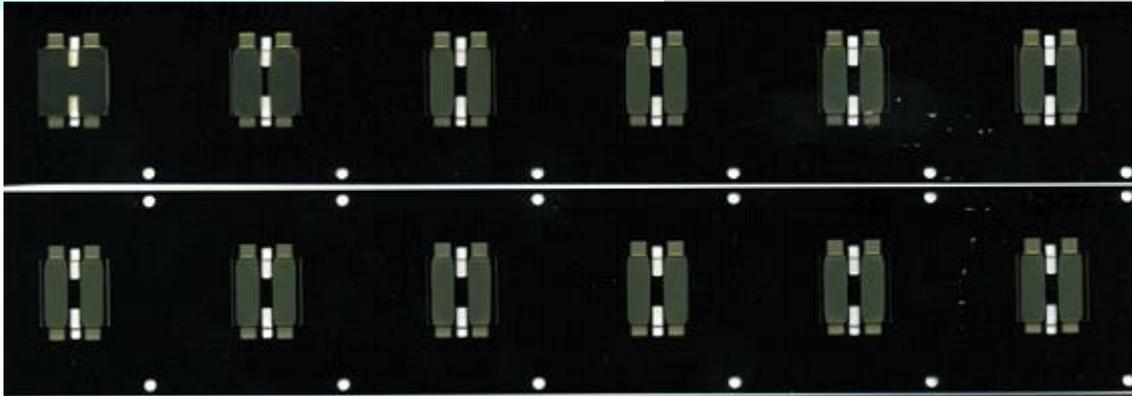
6202C Flow after B-Stage is consistent for up to 2 weeks
(B-Stage substrates may need pre-dry if stored for more than 8 hours)

6202C AFTER B-STAGE & CURE



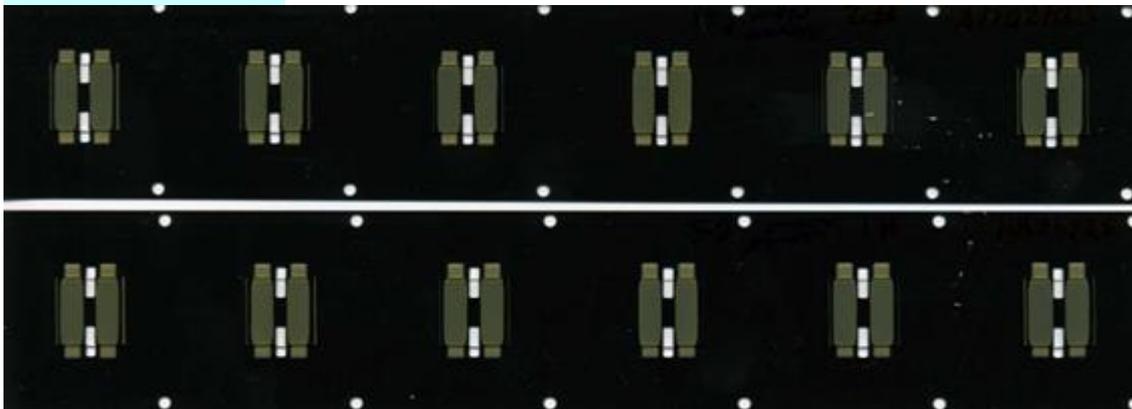
AFTER B-STAGE

B-stage Condition: 90min @ 125°C



No voiding after B-Stage or Cure

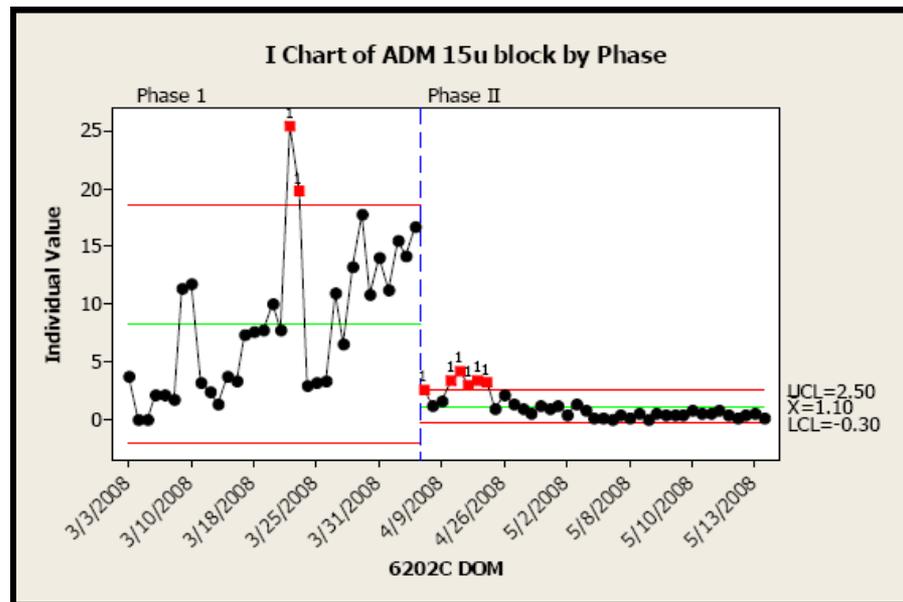
AFTER CURE



6202C PARTICLE SIZE IMPROVEMENTS



- 6202C has undergone several raw material and process improvements to control the oversized particles – to enable thinner bond lines (<20 microns)



Average Particle Size ≤ 15 microns (ATM-0075)
Maximum Particle Size ≤ 20 microns (ATM-0075)

TYPICAL 6202C COMPLAINTS



- Voiding
 - 6202C can form severe channel voids during cure (due to moisture in substrate). The important process factors are:
 - A) Short B-Stage (Minimum 75 minutes required at 125°C)
 - B) B-Stage Oven temperature variation
 - C) Long gap (>8 hrs) between B-stage & Die-Attach without Pre-Dry
- Particle Size Issues
 - As customers move to thinner bond lines, over-size filler particles may become a concern
 - Several process and raw material improvements have been made to enable up to 20 microns bond line
- Bleeding after Printing
 - 6202C is designed for soldermask substrates. May be used on non-soldermask substrates if B- Staged within 3 hours after printing
- Molding Compound Penetration
 - Reduced Die-Attach time (<0.5s) or bonding head planarity issues can leave regions without the die-attach paste (especially around fuse banks) where molding compound can penetrate

TYPICAL 6202C PROCESSING ISSUES



- Customers have moved to much faster processing on DRAM assembly lines to increase UPH by making several changes
 - Reduced thawing time
 - Concern: Trapped air voids during printing
 - Reduced B-Stage time (from recommended 90min to 75/60 mins)
 - Concern: Voiding during cure
 - Reduced Die/Attach time (from recommended 0.5s to <0.2s)
 - Concern: Uneven / poor wet-out after die-attach
 - Increased substrate temperature
 - Concern: Warpage and substrate outgassing

- Customers must understand the limits of each processing parameters and interactions between them

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6202C FAILURE ANALYSIS

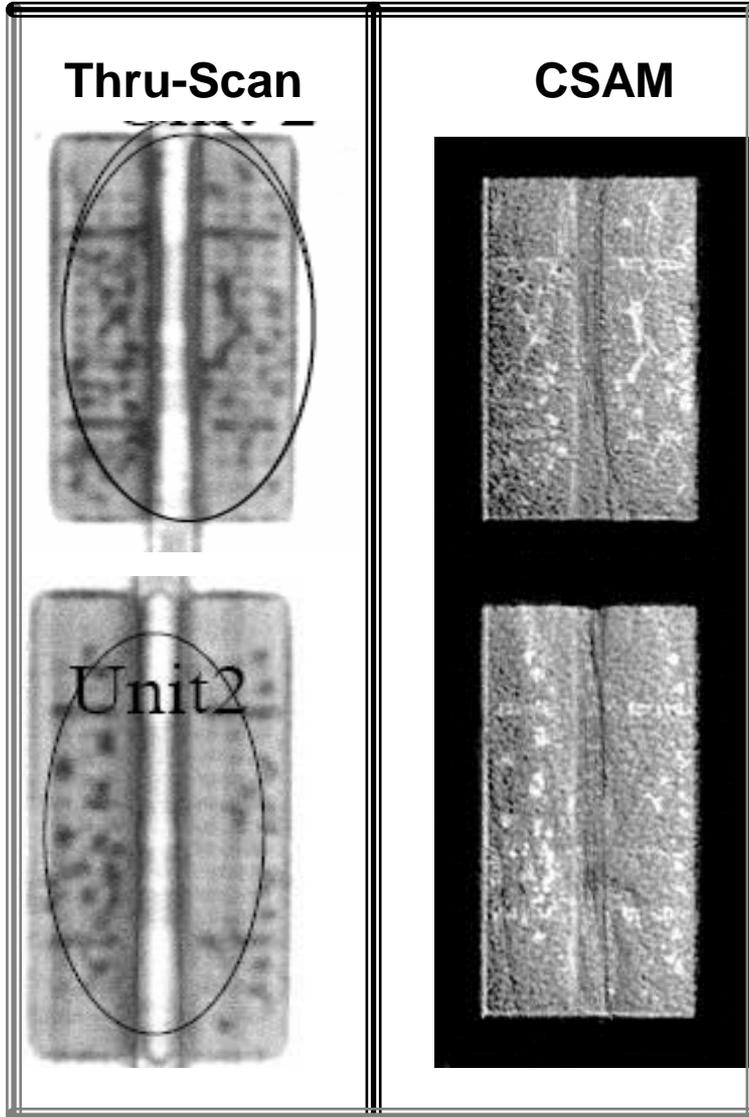
THRU-SCAN (SAT)

CSAM

PARALLEL POLISHING

SEM

CSAM & THRU-SCAN CORRELATION



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OBJECTIVE

To confirm that voiding / delamination is related to PBOC adhesive (and not to molding)

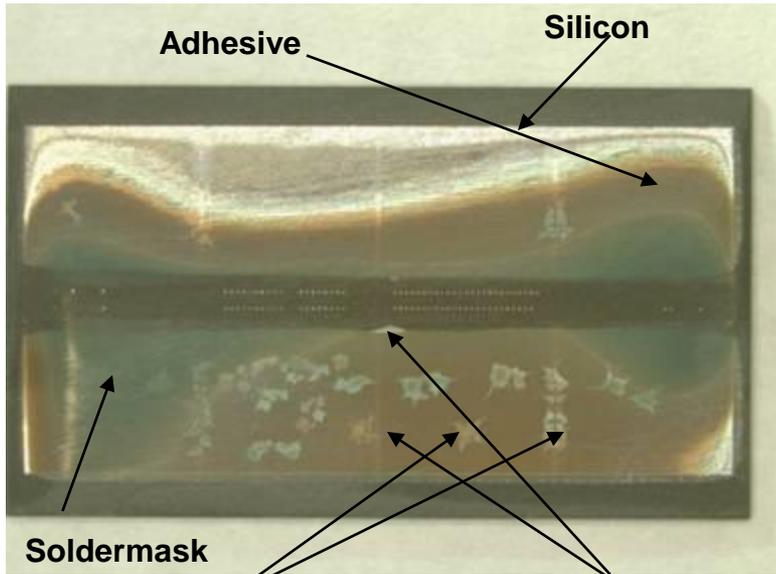
=> Good correlation proves that voiding exists in PBOC adhesive layer

PACKAGE AFTER SUBSTRATE GRINDING

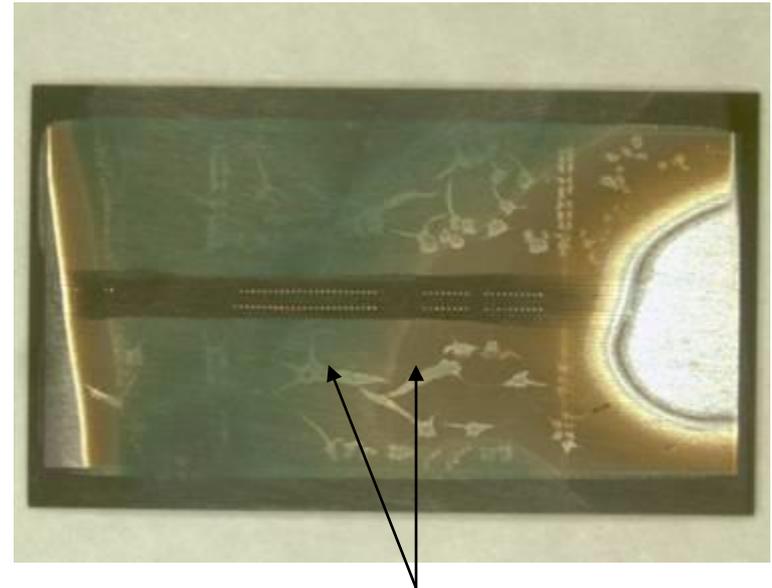


Effect of Baking on Voiding

With Bake



No Bake



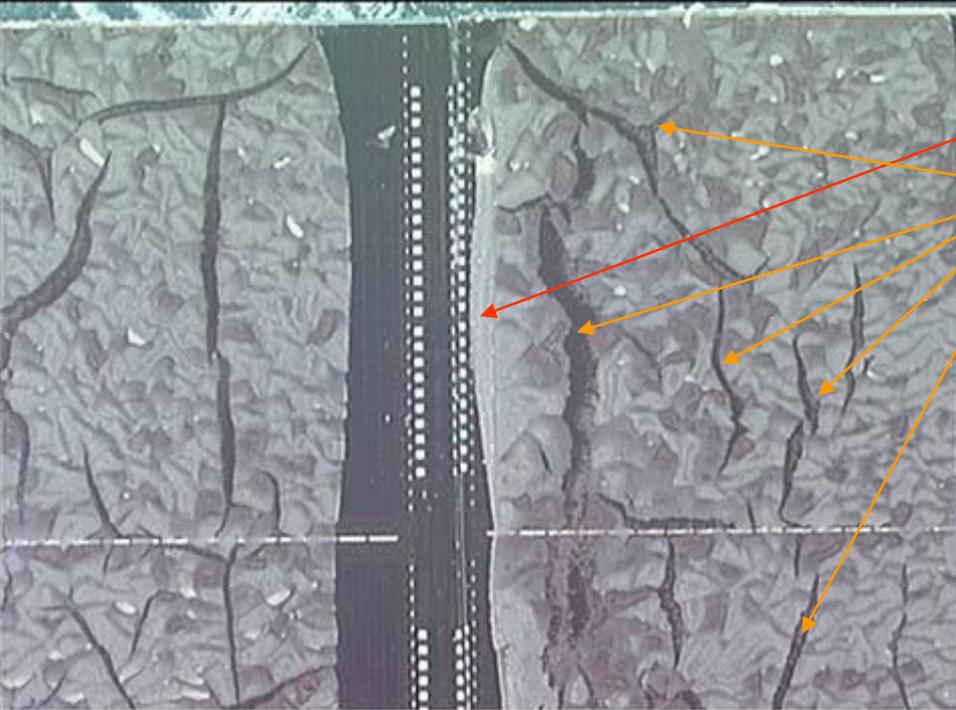
PACKAGE AFTER DIE PEEL OFF



Area of high flow

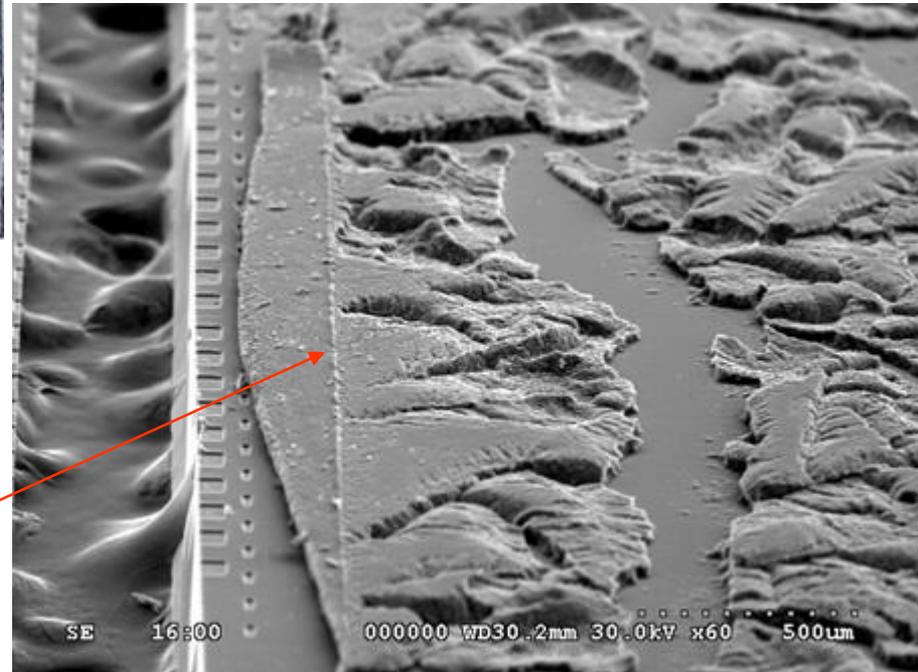
Channel voiding

SEM image showing adhesive squeeze out



Micro-photograph showing adhesive squeeze out

Die edge impression



TRAINING SUMMARY



- 6202C is the industry standard printable D/A material for BOC packages with following features:
 - Low stress for large dies
 - Easy processibility with good flow and wet-out
 - Lower particle size version available for lower BLT (≥ 20 microns)
 - Wealth of processing and performance data at all major DRAM assembly lines

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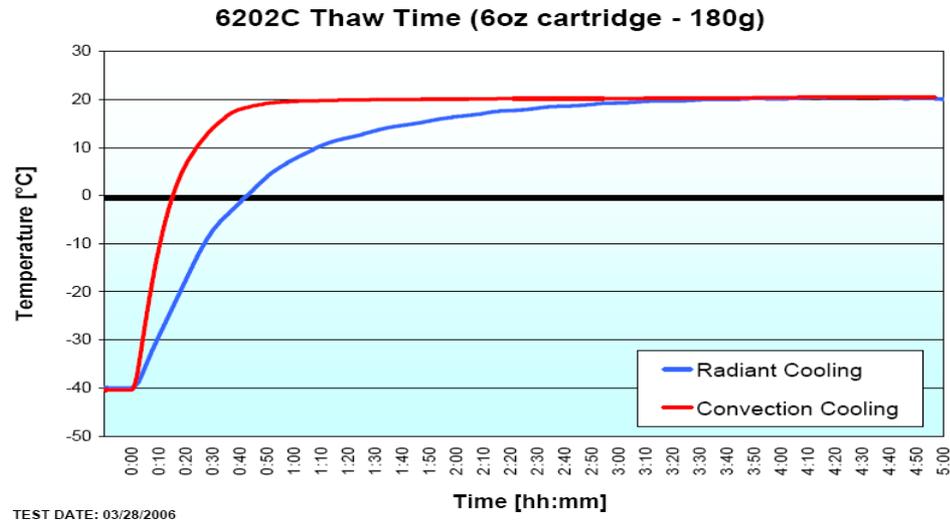
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ADDITIONAL INFORMATION

6202C STORAGE, HANDLING & THAWING



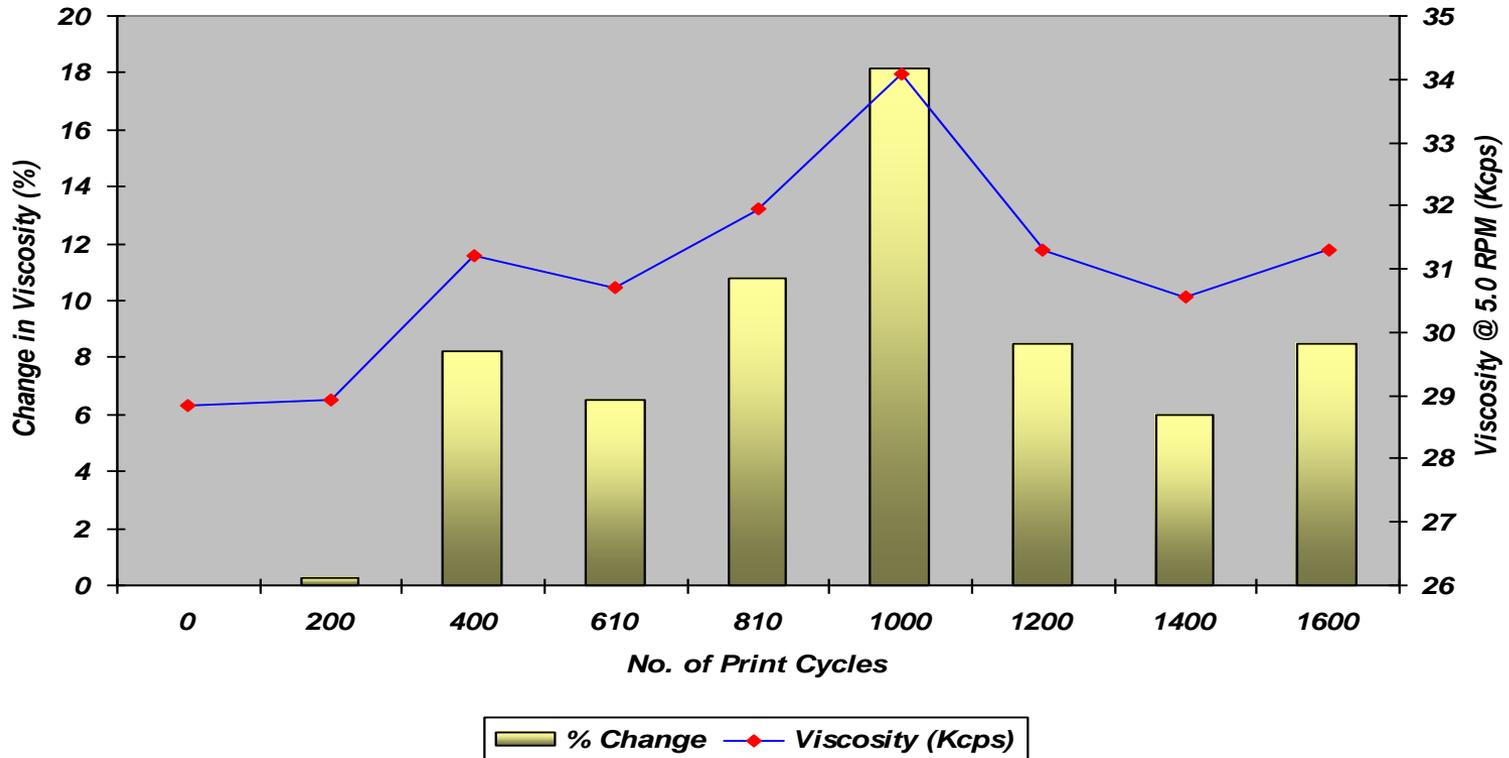
- **Store at -40°C**
 - Store at -40°C for maximum shelf life of 12 months
- **Handling & Thawing**
 - Remove from -40 °C storage and allow contents to reach ambient temperature
 - Unused material may be refrozen several times, provided the total room temperature work life is not exceeded (work life at room temperature is 2 weeks)
 - Thawing Recommendation: 1hr under a fan / blower (Convection) OR 3hrs without convection (Radiant)



6202C PRINTER OPEN TIME



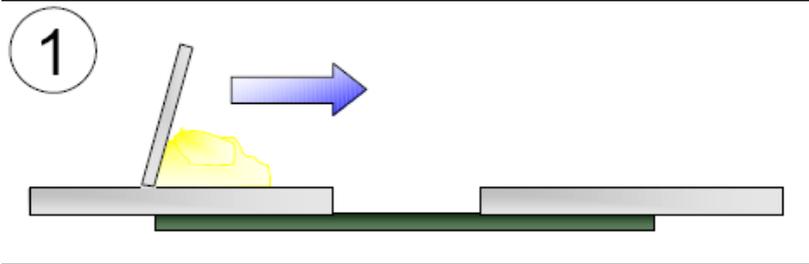
Up to 8 hours open time on printer with <20% increase in viscosity



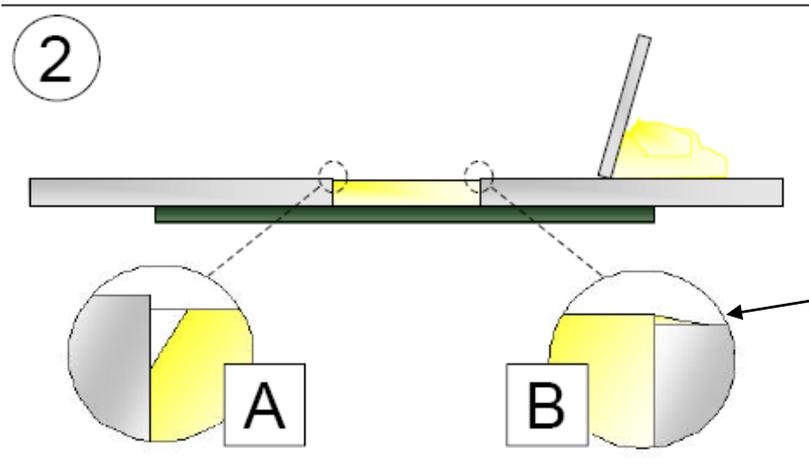
After ~ every 200 print cycles half the paste was removed and the viscosity measured using a Brookfield DV-III+ viscometer, cp51, 5.0 RPM @ 25°C. The screen was replenished with unused material and the cycle continued.

200 print cycles = approx. 1 hour printer time

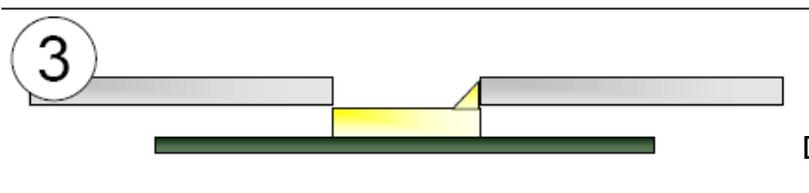
DOG-EAR THEORY



Print Stroke Direction

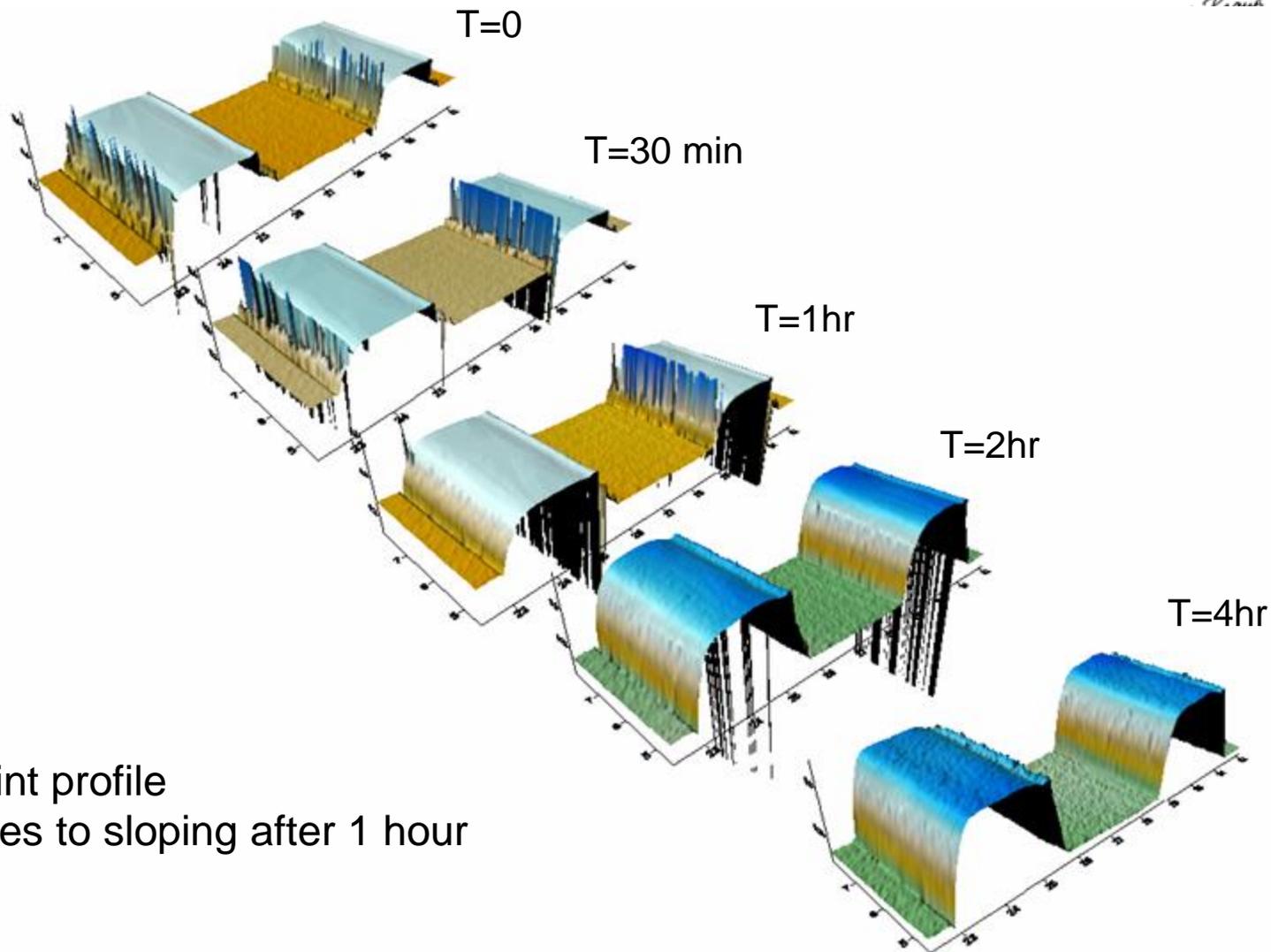


Squeegee drags the adhesive at the rear-end and makes an over-run



During stencil separation the over-run adhesive sticks out as the dog-ear

6202C WET PRINT PROFILE STABILITY



- Flat print profile
- Changes to sloping after 1 hour

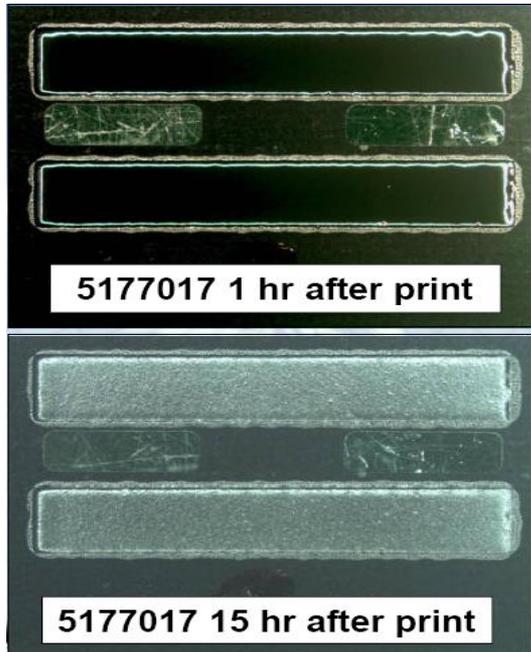
EFFECT OF SOLDERMASK ON BLEEDING

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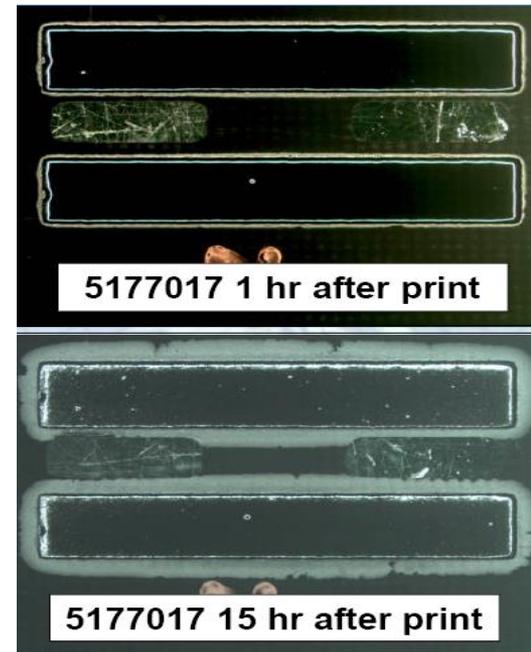
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6202C designed for soldermask substrates only!!

SUBSTRATE WITH SOLDERMASK



SUBSTRATE WITHOUT SOLDERMASK

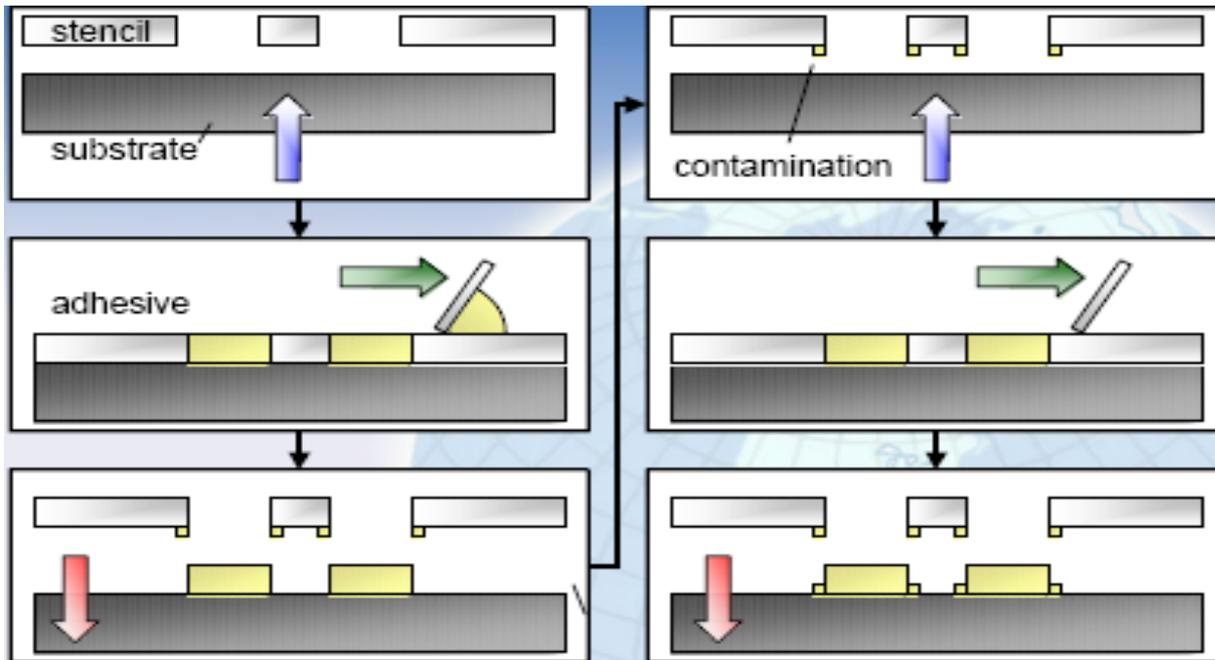


6202C may be used on non-soldermask substrates with

- ⊕ Very good stencil wiping
- ⊕ Very good contact between substrate & stencil (No deflection)
- ⊕ 60° squeegee angle
- ⊕ Control Staging time between Printing & B-stage (<3 hrs)

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STENCIL CONTAMINATION & BLEEDING



Stencil Contamination increases the print pad width and makes bleeding worse

6202C PHYSICAL PROPERTIES



Physical properties		Unit	6202C
Appearance :	Color		Yellow
Density		g/cc	1.1
Viscosity :	@5.0rpm	cP	28,000
	TI		2.3
DSC :	Onset	C	151
	Peak	C	185
	Delta H	J/g	-27
Tg :	after cure	C	36
	after PMC	C	
Ion content :	Na+	ppm	< 20
	K+	ppm	< 20
	Cl-	ppm	< 25
	NH4+	ppm	120

6202C MECHANICAL PROPERTIES



Mechanical Properties		Unit	6202C
CTE : P.M	a1	C/ppm	70
	a2	C/ppm	350
CTE : P.M	a1	C/ppm	
	a2	C/ppm	
Green strength @RT, 120x120	B-stage	kgf	5.5
Green strength @100C, 120x120	B-stage	kgf	N/D
Green strength @175C, 120x120	B-stage	kgf	N/D
DSS @RT : 120x120	Cure	kgf	4.5
HDSS @260C : 120x120	Cure	kgf	0.3
HDSS @260C : 120x120	PMC	kgf	1.2
HWDSS @260C : 120x120	PMC	kgf	N/D