Die Attach Film (DAF) for Breakthrough in Manufacturing (BIM) Application

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Abstract

Die attach film (DAF) is a relatively new generation die attach method in the semiconductor field – widely used for stacked die applications. DAF is also highly recommended for thin die (≤ 100um) application to avoid broken wafer and die crack issue. Basic process flow for DAF assembly processing involves die bonding followed by oven curing for 60 minutes at 130ºC for strip-to-strip leadless package assembly. Altering DAF application into Breakthrough in Manufacturing (BIM) application with reduced curing time from 60 minutes to 90 seconds will be a challenge with many consequences to look into. DAF is the best solution to sustain BLT and reduce tilted die issues, besides the possible risk from delamination and collet contamination due to insufficient curing. This paper covers the characterization of DAF with snap curing and monitoring of possible implications arise with reduced curing time.

1. Introduction

Semiconductor packaging evolved from conventional methods to more complex processes. Electronic packages kicked off from dual in-line plated-through-hole packages (PTH) in the 60's and 70's to surface mount technology (SMT) and 80's to current leadless and wafer level packaging. Miniaturization of packages and die thickness reduction has introduced complex methods of the die attaching process. The five known die attach processes used in semiconductor packaging is eutectic bonding, epoxy die attach, tape die attach, soft solder die attach and Flip Chip die attach. For High Powered or 'jelly bean' applications, the die is usually eutectic bonded onto the lead frame or substrate using e.g gold-tin or gold silicon solder. For low-cost, low-powered applications, the die is often glued directly onto a substrate using epoxy adhesive. Epoxy die attach materials have encompassed the use of polyimide or silicone based adhesives. Epoxy die attach adhesives can be conductive or non-conductive depending on the application.

The latest trend is to apply adhesive directly on to the wafer backside to provide an even layer at the bottom of the chip and allow good die positioning on the substrate. The so called wafer back side coating (WBC) is more commonly used for non-conductive adhesive applications to achieve good placement accuracy and to maintain desired bond line thickness (BLT). Better results were found with die attach film (DAF), the more recently developed die attach adhesive which is highly recommended for thin wafers (<100um) and stacked die application.

Handling thin dies presents enormous challenges in providing consistent BLT, fillet height control, die tilting, die placement and epoxy bleeding. Wafer back coating (WBC) can be used with relatively thin dies but a better solution like DAF is needed to achieve thinner BLT and stack height.

Figure 1: DAF Construction

Standard DAF for leadless packages with requires 1 hour post-die bonding oven cure to allow complete curing. Implementing DAF application into BIM line with curing less than 2 minutes is a challenge that may lead to different output responses – which is the core objective of this study.

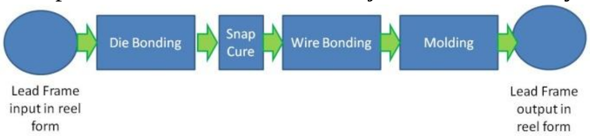

Figure 2: BIM Line Workflow

2. Methodology

Evaluating DAF for BIM line application requires a characterization study with varying die bonding and snap curing temperatures. Die bonding temperature will determine the initial wetting of DAF to the lead frame while snap curing determines the bonding strength.

The first run **(Run 1 – Table 2)** of the evaluation is to determine the best working die bonding temperature and the second is to determine the snap curing temperature at fixed time to allow complete curing of DAF attachment.

Table 1: Test Vehicle Information

Evaluation Vehicle Details	
Die Size	<100um
Package	SOT Package
Back Coating	DAF
Platform	BIM Line
Wire Diameter	20 um

Snap curing characterization initiated referring to DSC profile at 180ºC **(Figure 5)** which requires approximately 10 minutes for complete curing.

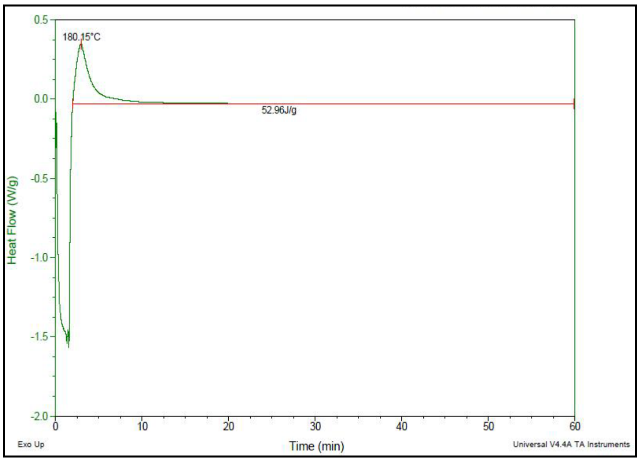

Figure 3: DSC @ 180 °C

Table 2: Run 1

Condition	Trial 1	Trial 2
Die Bond Temp (°C)	Low	High
Snap Curing	Fixed	
Snap Cure Duration	Fixed	
Wire Bond Temperature	Fixed	

Final temperature at die bonding and snap curing will be determined based on output responses – die shear - collected from Run 1 and Run 2.

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Table 3: Run 2 – Snap Cure Characterization

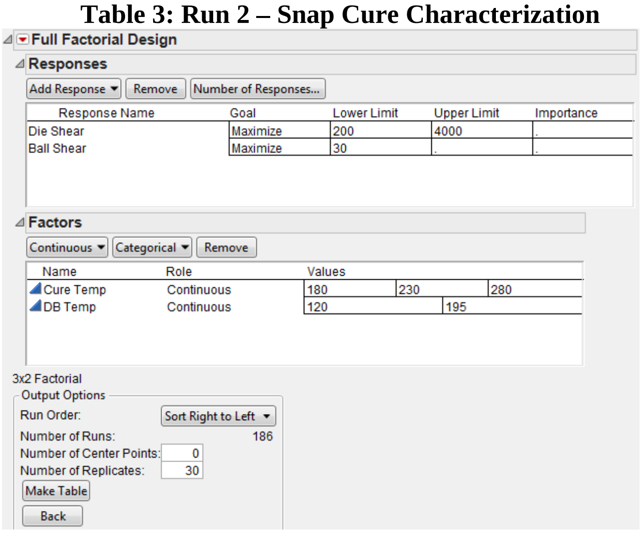

Table 4: Proposed Reliability Plan

Stress Test	Condition	Requirement
MSLA	Level 1, 2	Pass MSL1, SCAT
MSLV	Level 1	Pass MSLT, SCAT
UHST	Ta = 130 ºC 85% RH PreCON MSL 1	96 hrs (required) 192 hrs (target)
THB	Ta = 85 ºC V = 3.6 V 85% RH PreCon MSL 1	1000 h (required) 1680 h (target)
TMCL	Ta = -65 to 150 ºC PreCon MSL1	200c/500c/1000c
HTSL	Ta = 175 ºC	200/500c

3. Results and Discussion

For Run 1, die bonding temperature varied from low to high to understand the effect on die shear and ball shear as the main output response.

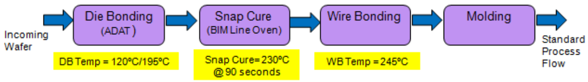

Figure 6: Run 1 Process Flow

Keeping all variables constant, more DAF squeeze out was observed at high temperature compared to low temperature on Run 1. But, die shear performance did not show any significant as plot in **Figure 9**.

Below finding on die shear confirms die bond temperature is not a significant factor to evaluate DAF in BIM line. Moving forward with Run 2, both die bond temperature and snap curing temperature combined into one DOE – **Run 2** -to understand the most significant factor.

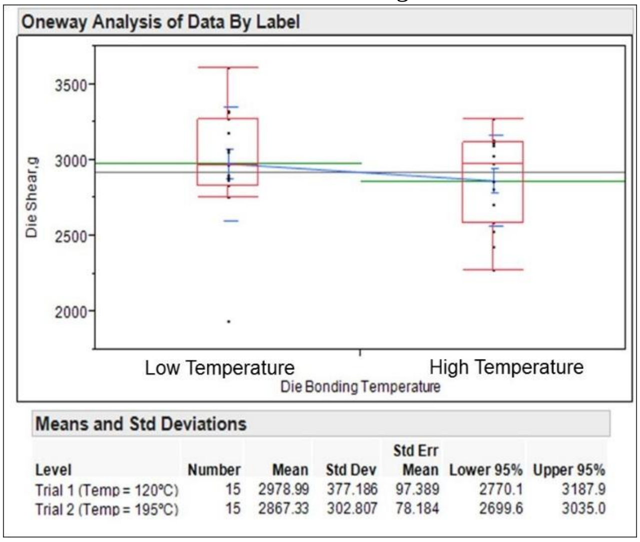

Figure 9: Die Shear Comparison

For Run 2, both die bonding and snap curing temperature combined into one DOE with constant snap curing time to understand the effect on output responses.

Based on Run 2 DOE profiler in **Figure 11,** no significant difference found on die shear with varying die bonding temperature. This is the same as observation collected from Run 1. For snap curing temperature, the profiler plot confirms both die shear and ball shear increase with increasing snap curing temperature. This observation confirms that snap curing temperature is a significant factor to determine the workability of DAF in BIM line.

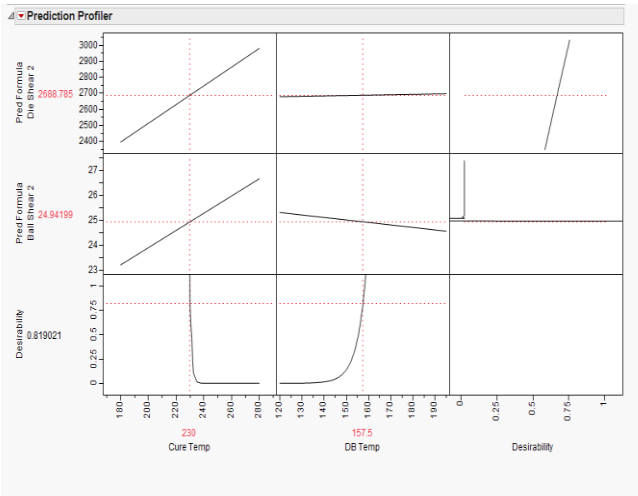

Figure 11: Characterization Profiler

Profiler adjusted to obtain the desired die shear (> 2kg) and proposed to fix the snap curing temperature at 230ºC with curing time for 90 seconds. To understand the behavior of DAF curing at 230ºC, another DSC study done with DAF at 230ºC @ 90 seconds. Profiler obtained in **Figure 12** confirms that DAF is fully cured at 230ºC when curing time set at 90 seconds.

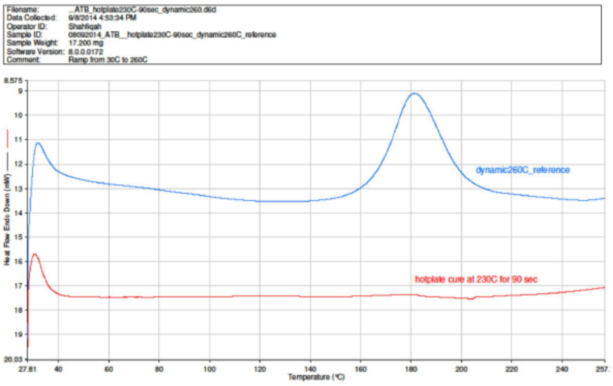

Figure 12: DSC @ 230ºC

All workability information collected concretely support the capability of ATBF-125E with 90second snap curing @ 230ºC. In order to make the study valuable, additional reliability tests were done on the same samples.

Reliability data collected on stress tests does not show any abnormal failure and confirms that using DAF with BIM line condition and snap curing for 90 seconds at 230ºC does not affect the reliability of the samples.

4. Conclusion

Based on all output response, DAF in BIM line is best to be processed with lower die bonding temperature and snap curing at 230ºC @ 90 seconds. Both reliability and workability passed confirms DAF is can be applied in BIM line condition.

5. Refference

- Marry Teo, Soh Choew Kheng, Charles Lee "Proces and Material Characterization of Die Attach Film for This Die Application", IEEE, 2006.
- S. Abdulla, S.Mohd Yusof, I.Ahmad, A.Jalar, R. Daud "Dicing Die Attach Film for 3D Stackked Die QFN Packages", Int'l Electronics Manufacturing technology Symposium, pp 73-75, 2007.