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Die Attach Optimization for DAF Delamination

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Keywords—*Delamination; Die Attach; Die Attach Film.*

I. OVERVIEW

Semiconductor packages delamination mechanism defect refers to interface adhesion failures between either die to die attach material, die attach material to die paddle interface, or mold compound material to die paddle interface delamination, all of which are equally critical, in any packages as illustrated in Figure 1. Most of the devices with minor delamination are not easily detectable during device testing, but may potentially cause product reliability and functional failure in certain applications in the field, especially after external mechanical stresses have been applied. The Semiconductor manufacturer may suffer heavy cost impacts if the suspected defective units have to be recalled as customer return. Thus, the semiconductor industry is aggressively striving to improve the delamination performance in Integrated Circuit packaging. However, to date, this task is complicated and difficult as the defective failure is highly dependent on the compatibility of the material characteristic that may influence the entire Integrated Circuit package system under certain stress level, both mechanical and thermal stresses.

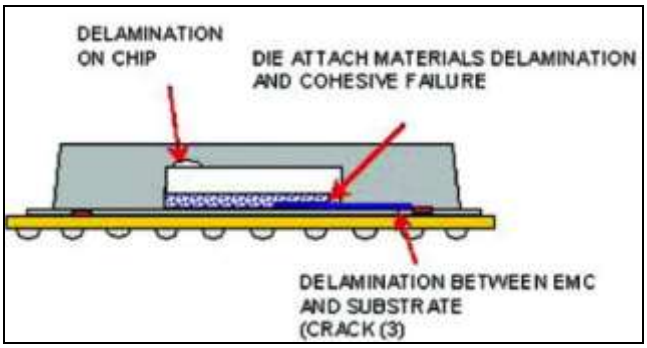

Fig. 1. Delamination mechanism

II. PROBLEM IDENTIFICATION

After Die Attach assembly, all units were checked for delamination after Reliability test using a Scanning Acoustic Microscope (SAM) operating in transmission mode. In the transmission mode, show minor- to total-pad delamination on units in the SAM image in Figure 2. Representative cross-section photo in Figure 3, shows thin gap between mold compound and die pad interface.

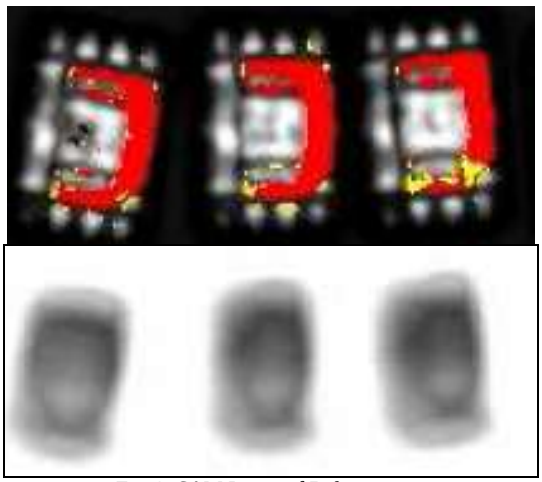

Fig. 2. SAM Image of Delamination

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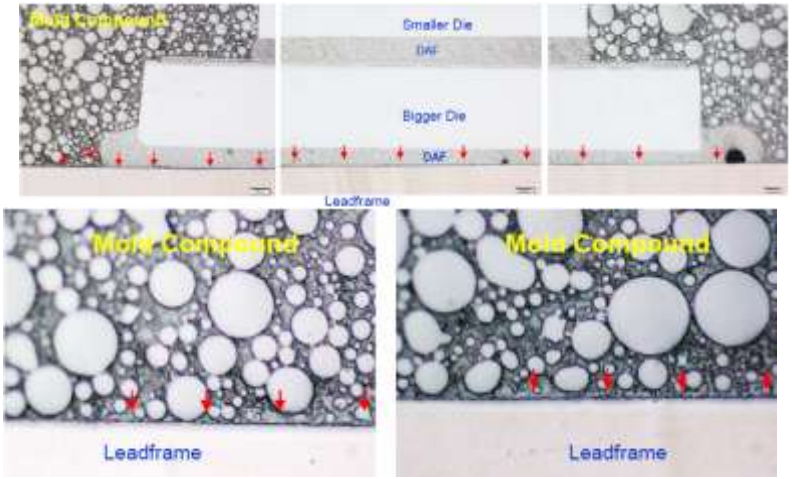

Fig. 3. Cross Section Analysis

III. ASSEMBLY PROCESS IMPROVEMENT

Die attach process optimization is unavoidable to ensure process robustness and package reliability when DAF is used. The major process difference as compare to conventional die attach process is the heat bonding. An experiment is performed to optimize the die attach parameters using die bonder. Three main process parameters are used in the Design of Experiment (DOE) using JMP Software. The parameters are (a) Scrub Cycle, (b) X & Y Scrub Amplitude, (c) Bond Time/Delay. This DOE optimization is targeted for enhance the adhesion of Die Attach Film into Leadframe thru Bond scrubbing mechanism as illustrated in Figure 4. The response of this experiment is interfacial delamination between DAF and die after die bonding. Scanning Acoustic Microscope (SAM) is used to check the delamination. Below is the table for Summary of Responses and Measurement Methodology base on the Design of Experiment (DOE) shown in Table I.

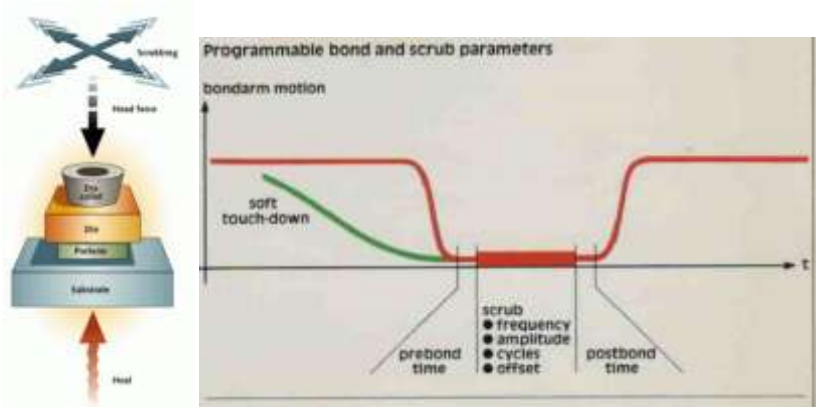

Fig. 4. Bond scrubbing mechanism

TABLE I. DOE Evaluation Matrix

Run	Variable			Response							
	Scrub Cycle	Both XY Scrub Amplitude	Bond Delay	Green Pad Test	Void	TSAM	Squeeze out			HDS	PAC Failure Mode
	(Spec: 3-6 cycles)	(Spec : 30-50um)	(Spec:200-400ms)	Spec: Rejected if >10% un-wet	Spec: rejected if single >5% Total :10%	Spec: Rejected if DA delam >10%	Spec: Rejected if >100um outside die perimeter			Spec: >0.4kg/mm2 (non-destructive)	Spec: Rejected if >10% adhesive to paddle
				xx: 10pcs	xx: 10pcs	xx: 10pcs	xx: 2pcs			xx: 10pcs	xx: 10pcs
							Ave	Min	Max		
*A1 – (R)	4	30	200	0	0	0	[illegible]	[illegible]	[illegible]	P	0
A2	2	30	200	0	0	0	51	32	68	P	0
A3			400	0	0	0	54	47	64	P	0
A4		50	200	0	0	0	[illegible]	[illegible]	[illegible]	P	0
A5			400	0	0	0	[illegible]	[illegible]	[illegible]	P	0
A6	4	40	300	0	0	0	[illegible]	[illegible]	[illegible]	P	0
A7	6	30	200	0	0	0	[illegible]	[illegible]	[illegible]	P	0
A8			400	0	0	0	[illegible]	[illegible]	[illegible]	P	0
A9		50	200	0	0	0	[illegible]	[illegible]	[illegible]	P	0
A10			400	0	0	0	[illegible]	[illegible]	[illegible]	P	0

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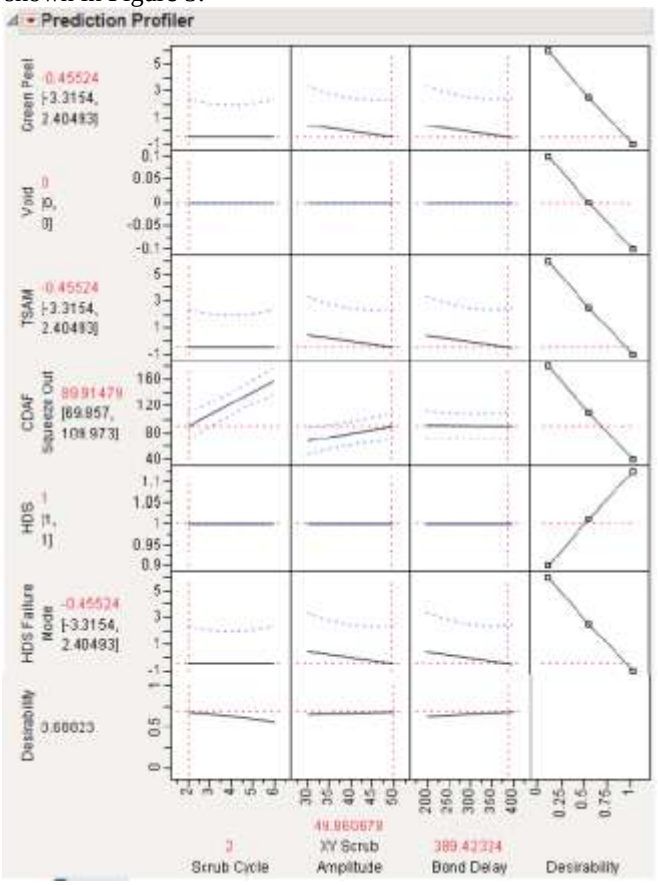
The experiment result is analyzed using JMP software to determine the most significant parameter in minimizing delamination between DAF to Leadframe interface. From the result of Figure 5 Prediction Profiler below, Scrub Cycle and XY Scrub Amplitude factors are the significant factors affecting particularly Delamination and DAF Squeeze Out response. All the rest of the responses are not affected by the DOE factors identified which can be considered statistically not significant (P-value > 0.05) as shown in Figure 5.



Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	3.8061224	21.32868	0.18	0.8642
Scrub Cycle	17.125	2.169024	7.90	0.0002*
XY Scrub Amplitude	1.1102041	0.413406	2.69	0.0363*
Bond Delay	-0.00898	0.041341	-0.22	0.8352

Fig. 5. DOE Prediction Profiler Result

Based on JMP Contour Profile, Process window identified (XY Scrub Amplitude: 25um – 35um; Scrub Cycle: 1- 2 cycles) met all the bond quality requirements (Green Peel, Void, TSAM, Squeeze Out, HDS, HDS Failure Mode).

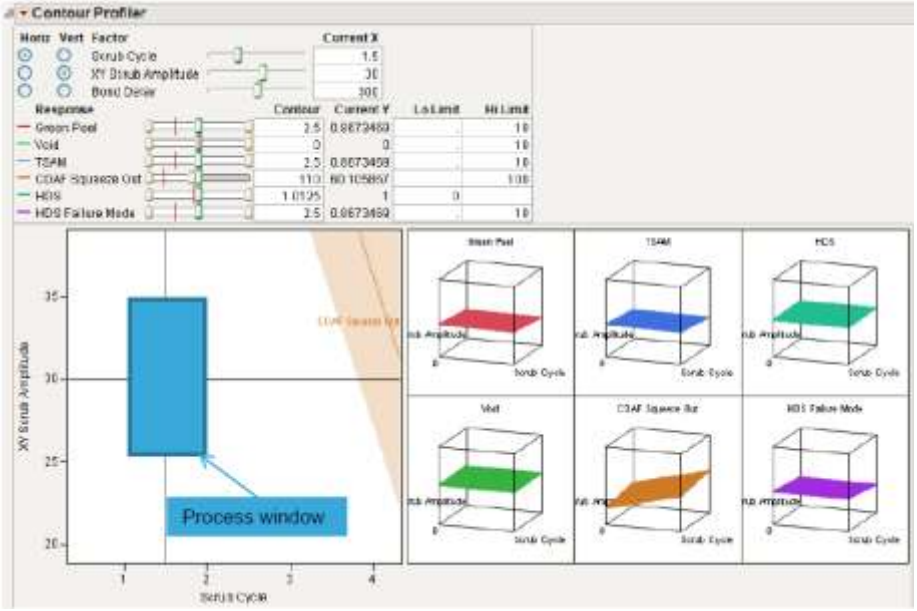


Fig. 6. DOE Contour Profiler

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After the Validation of process window identified will meet all the quality. All assemble sample units were checked for delamination after Reliability Test using a Scanning Acoustic Microscope (SAM) operating in transmission mode. In the transmission mode, show No delamination on units in the SAM image in Figure 7. Representative cross-section photo in Figure 8, shows No delamination noted on unit cross section inspection.

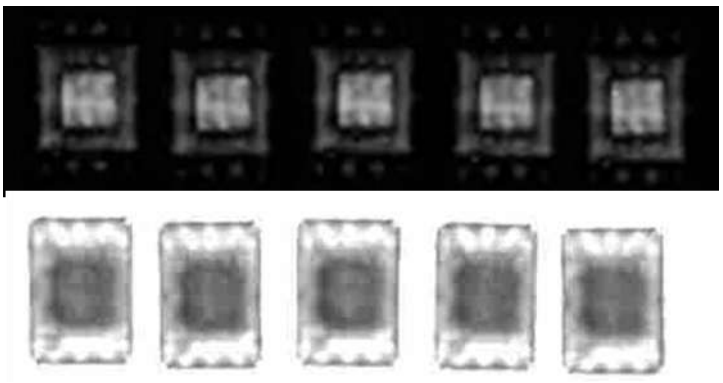

Fig. 7. Bond Line Thickness (BLT) Verification result

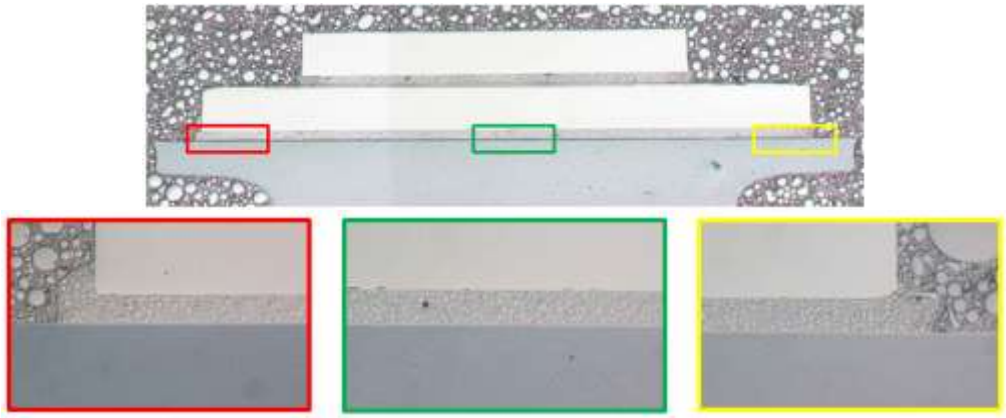

Fig. 8. Die Shear Test (DST) Verification result

REFERENCE

[1] Diebond Machine Process Capability Study, July 2010.
[2] J-STD-020C, Joint IPC/JEDEC Standard for Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface-Mount Devices, Jul 2004
[3] Die Attach ESEC2008 manual

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