

Epoxy Staging Time Effect on Voiding & Adhesion Strength

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Abstract— This research interested in studying about property of epoxy staging for epoxy voids in die attach process. Die attach process is a very important process in the integrated circuit (IC) packaging. It is a popular adhesive material used for attaching between die and Leadframe of a package which is an epoxy. Oven cure process is also important to make a complete epoxy due to cross linking to enhance microstructure of epoxy stiffness. The Staging or waiting time before Oven cure process will affect the void under die of multichip package because the long duration of attaching will increase the risk of void under die. In experiment, the staging or wait time before Oven cure were varied from 0 until 5 hours with a step of 1 hour and analyzed the void under die of epoxy by die shear test, ball line thickness, delamination, x-ray and reliability test. The results confirmed that the wait time will affect the void under die of die attach process in IC packaging.

Keywords— Adhesion Strength; Epoxy Voids; Die Attach; Staging Time; Waiting Time.

I. INTRODUCTION

A normal material used for attaching between die and leadframe of a package which is an epoxy. Voiding underneath the die resulted from the trapped vapors during flux out gassing and oven curing of the epoxy. Voids formation is dependent on the epoxy paste adhesive rheological properties, the Oven Cure profile and gas parameters used and their interactions thereof. Measurement of the percentage voiding can be done automatically using Xray machine. Epoxy Staging time refers to the waiting time between die attach and Oven Curing as illustrated in figure 1. Stage time is the time the package is left uncured after die bonding. The general rule is that shorter stage times lead to better manufacturability.



Fig. 1. Epoxy Staging Time

Very often, high power applications feature small package sizes and their assembly process involves many packages on a single strip. Therefore, die attach paste used in these

applications must withstand long post-dispense time periods while awaiting die placement and subsequent adhesive curing.

A typical specification, based on X-ray inspection, is an allowable maximum of 10% voids, and 5% individual void.

II. PROBLEM IDENTIFICATION

Voids were measured using an x-ray inspection system. In each case voiding was minimal, but we observed voiding on both interconnect layers (see Figure 2):

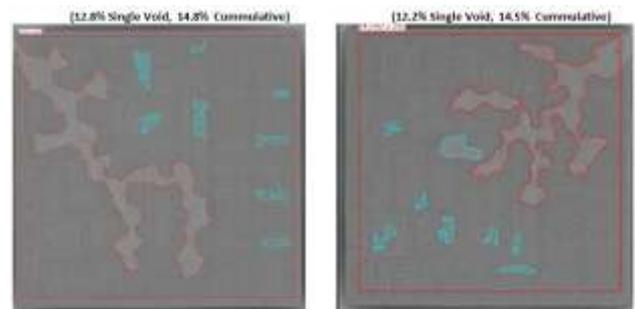


Fig. 2. Epoxy Voids visual image in X-ray

The presence of voids in the die attach material affects the quality and reliability of the device itself, refer to figure 3 for sample of Epoxy Voids visual image in Cross Section. Large die attach voids result in low shear strength and low thermal/electrical conductivity, and produce large die stresses that may lead to die cracking. Small voids provide sufficient shear strength and electrical/thermal conductivity, while 'cushioning' large dice from stresses. Total absence of voids may mean high strength, but it may also induce large dice to crack. The strength of die attachment is measured using the die shear test.

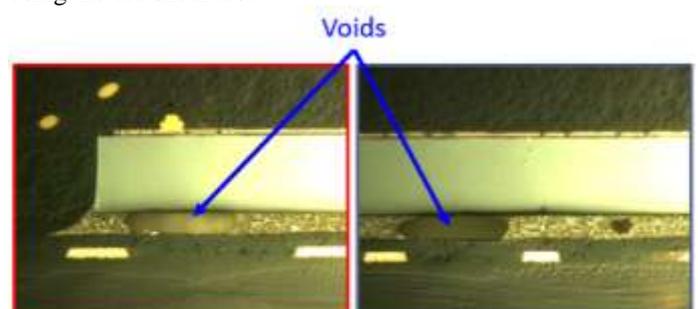


Fig. 3. Epoxy Voids visual image in Cross Section unit

III. EVALUATION ASSEMBLY PROCESS IMPROVEMENT

“How do I reduce my die-attach epoxy voids?” is a question I am often asked by customers in the semiconductor field. Excessive voids are bad news in die-attach applications, not only because they affect the joint mechanically as a place where cracks can propagate, but also because they affect the electrical and thermal conductivity of the device.

In this section, we describe methodology to study the effect of waiting time to void under die for Oven cure process in Integrated packaging. This section, we describe methodology to study waiting time before Oven cure process in IC packaging process by inspect properties of the epoxy with different waiting time after die attaching. The process of die attach using conductive epoxy as adhesive to start by allowing an epoxy attach onto the die and put the die on the leadframe. The sample were adhered using epoxies. After that, the samples were varied waiting time from 0 to 5 hours with a step of 1 hours to analyze effecting waiting epoxy in term of voiding and adhesion strength and the diagram of operation is shown as Fig.4.

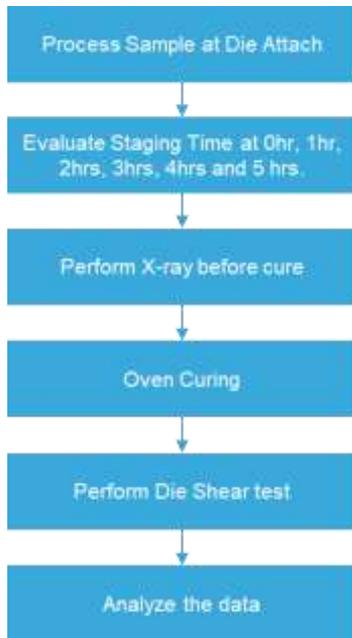
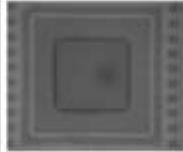
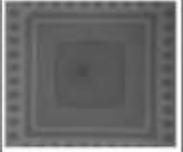
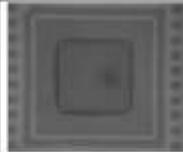
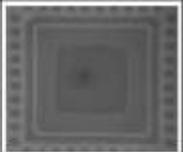
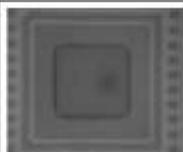
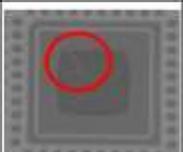


Fig. 4. Diagram of experimental study.

The results of void under die by using x-ray machine are shown in table I. From table I, the staging time before oven cure were varied from 0 until 5 hours to observe void under die of epoxy. The results show that the sample found void under die at 4 hours of staging time. The void under die is observed at 5hours of waiting time.

Using Statistical tool ANOVA (Analysis of Variance) There is Significant change in coverage or voids percentage formation was observed for the packages cured after 5 hours of staging time following die bonding as shown in figure 5.

TABLE I. Design of the Experiment

| Staging Time | X-ray Image | Staging Time | X-ray Image |
|--------------|--|--------------|---|
| Zero hour |  | 3 hours |  |
| 1 hour |  | 4 hours |  |
| 2 hours |  | 5 hours |  |

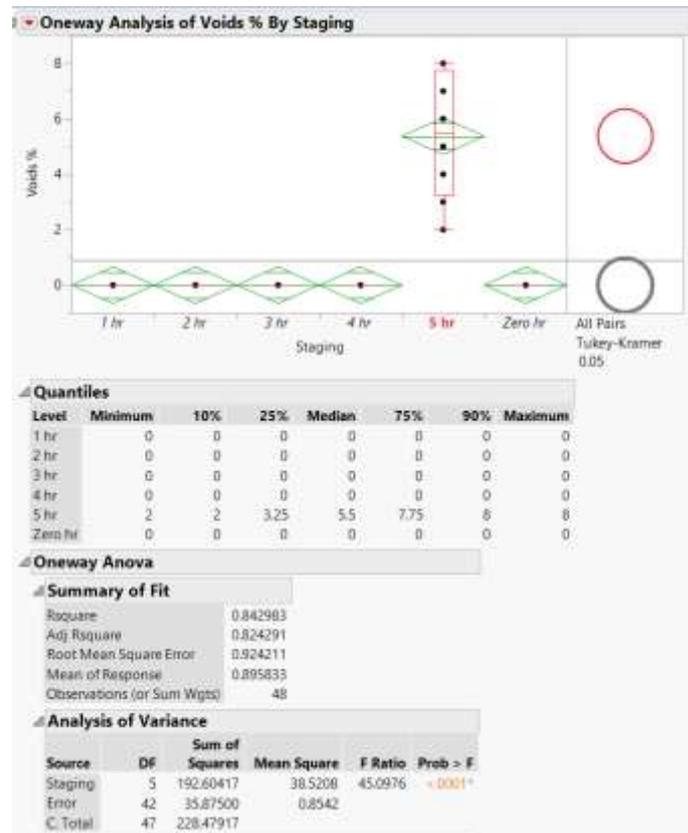


Fig. 5. Epoxy Voids ANOVA (Analysis of Variance)

No significant change in Adhesion Strength or Die Shear Test response was observed for the packages cured after up to 5 hours of staging time following die bonding as shown in figure 6.

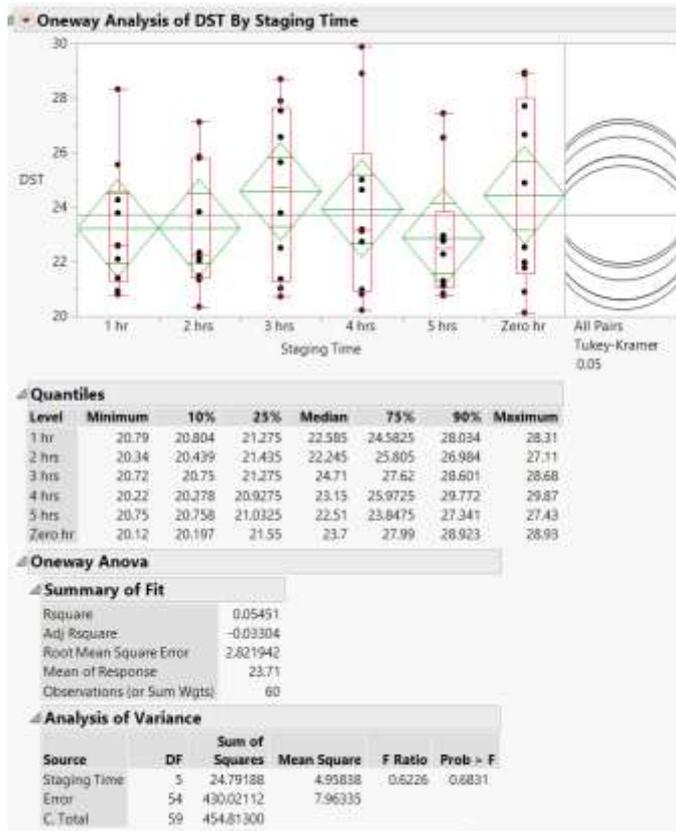


Fig. 6. Adhesion Strength ANOVA (Analysis of Variance)

IV. CONCLUSION & RECOMMENDATIONS

This research studied about effect of waiting time before snap cure process to void under die for die attach process in integrated packaging. In experiment, the wait time before Oven cure were varied from 0 until 5 hours with step of 1 hour to analyze effecting waiting time of epoxy to failure performance. The results show, based on statistical analysis at 95% confidential interval, there is no significant difference of adhesion strength between 0 hr vs 5 hrs staging time (after die attach). No voiding is found for 0-4 hours staging time.

REFERENCES

- [1] JMP Design of Experiments, Release 7 Copyright ©2007, SAS Institute Inc., Cary, NC, USA ISBN 978-1-59994-413-5.
- [2] The Lean Six Sigma, Michael A. George, McGrawHill, 2002.
- [3] Diebond Machine Process Capability Study, July 2010. Effect of Waiting Time to Void Under Die for Snap Cure Process in Integrated Packaging
- [4] Effect of Waiting Time to Void Under Die for Snap Cure Process in Integrated Packaging, Varunee Paktramook, Kessarat Ugsomrat, Chalernsak Sumthipibul Department of Industrial Physics and Medical Instrumentation, Faculty of Applied Science King Mongkut's University of Technology North Bangkok