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Analyzing the DAF Voids due to Die Warpage for Thin Die

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Abstract— *The objective of this study is to develop a robust die attach process and tooling design using adhesive material of DAF after studying the material characteristics and knowing the effects of each important property relating to the performance of reliability of package. The result of Die Attach tooling selection shows that design Nozzle Type Rubber tip shank prevents die warpage problem and eliminate the delamination or DAF voids.*

Keywords— *DAF Voids; Die Attach; Die Warpage; Delamination; Rubber Tip Shank.*

I. INTRODUCTION

The Semiconductor package trend miniaturization has created challenges to conventional die attach process. When wafers need to be thinned down beyond 100 µm, challenges in die attach process become great and die attach paste may not be suitable in most cases. The selection of die attach material becomes critical to ensure package robustness and reliability. When die paddle of a package is reduced to less than 0.3mm, the control of bleed out of paste becomes critical. The rheology of paste will result in creeping of the material to the edge of die and contaminate the bonding pad when the die is placed and seated upon a certain amount of dispensed paste. New generation of die attach material has been introduced amid this complication, die attach film (DAF) is commonly used for thin die with less than 100 µm as shown in Figure 1. DAF replaces paste in stacked packages for its good control of paste bleed, creeping effect to die edge and also consistent bondline thickness (BLT) at desired thickness.

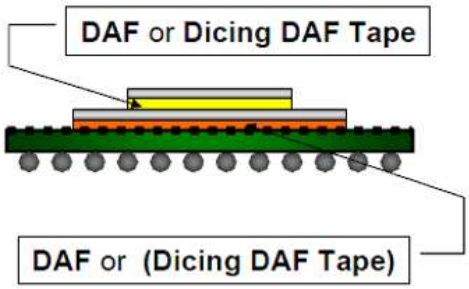

Fig. 1. Die Attach Film.

New generation of DAF tape incorporates wafer dicing tape and adhesive in one, namely the Dicing Die Attach Film (DDAF) in Figure 2, which is mounted onto the back of wafer. The wafer which is mounted with DDAF will be diced into the predetermined die size and the diced chip will be picked and placed directly to a leadframe or substrate with adhesive at the back. Today, DDAF has been proved to reduce manufacturing process steps and improve productivity. The gain in productivity has improved total package cost, irrespective of the higher material cost when conventional die attach paste is replaced by DDAF.

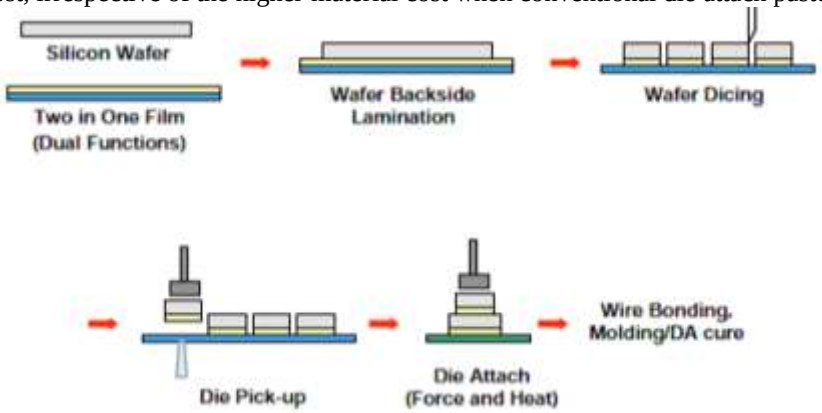

Fig. 2. Dicing Die Attach Film Assembly Process

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II. PROBLEM IDENTIFICATION

The common concept of having high bond force to eliminate delamination or DAF Voids when DAF is applied has been proven to be inaccurate. Further investigation into the tooling used has been carried out. The design of die attach rubber tip shank in affecting the delamination or DAF voids is then observed. It is essential to have a completely flat surface on the rubber tip collet to ensure 100% adhesion between two interface whenever high bond force is used. In reality, high temperature rubber collet tends to warp after it is inserted into collet shank as there is a need for interference fit to hold it in place during die bonding process. As shown in Figure 3, the thin die will warp together with the contour of the collet when it is inserted into rubber tip shank. During die bonding, DAF will be placed on the heated bottom die surface, the peripheral of DAF underneath the top die will be melt faster than the center portion. Air will be trapped in between DAF and bottom die as the peripheral of the DAF has already been "sealed" by the high bond force. In contrary, when low bond force is used, sealing effect along the peripheral of the die is not significant. Air trapped in the center is able to escape when the die is released from the collet and it will be adhered onto the bottom die surface with minimum force.

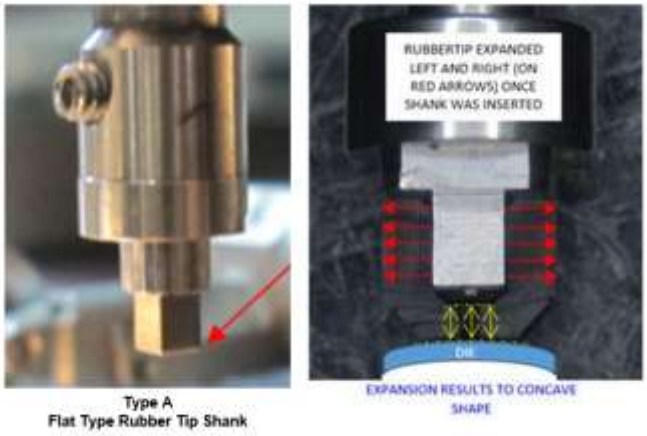

Fig. 3. Flat Type Rubber Tip Shank

Assembly sample were checked for time-zero delamination using a Scanning Acoustic Microscope (SAM) operating in transmission mode. In the transmission mode, a circular in shape DAF Voids was observed. Voids is greater than 5% single, SAM image in Figure 4. It was verified on Cross sections that circular pattern is DAF voids, analysis confirmed that there is a delamination or gap between DAF and substrate as shown in Figure 5. Perform peel-off test on diebonded units to check if voids already manifested at die bond process as shown in Figure 6. Hence, these DAF voids or delamination were rejected from further assembly and testing to avoid complications such as probability to initiate popcorn failures during MSL3 preconditioning.

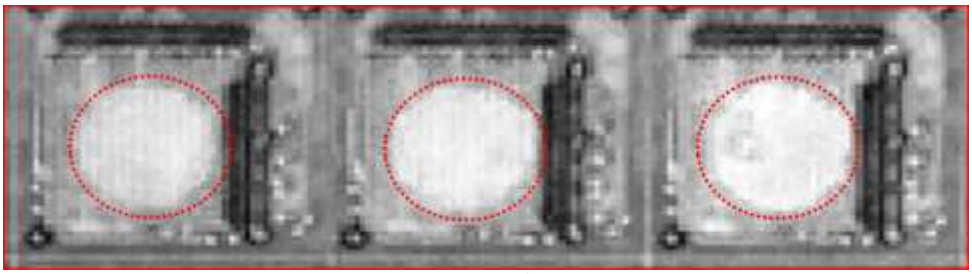

Fig. 4. SAM Photo of DAF Voids

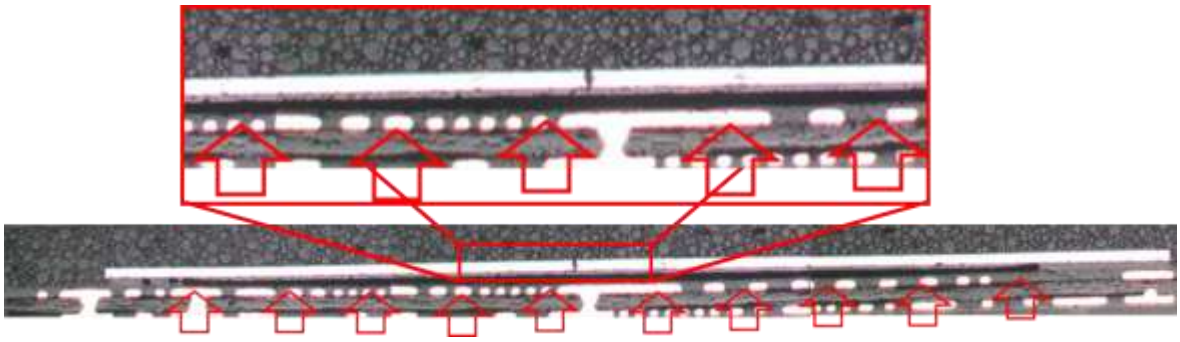

Fig. 5. DAF Voids in Cross Section Analysis

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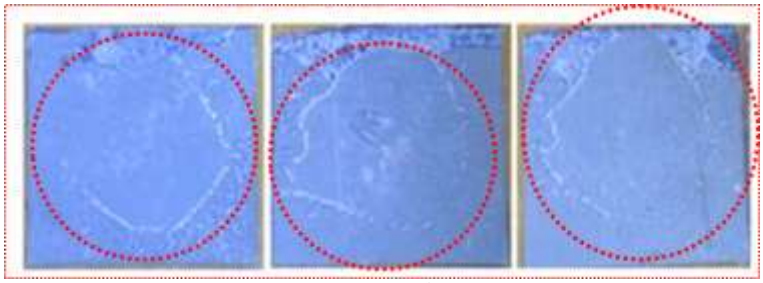

Fig. 6. Optical Photo of DAF Voids

III. Assembly Process Improvement

From this understanding, a new rubber tip shank with different design have been tooled up in solving the problem of delamination due to the warpage of die caused by concave die pickup collet. The new Nozzle Type Rubber Tip shank is designed to avoid rubber tip to form concave shape. The Rubber Tip shank is changed to Nozzle Type to hold the rubber tip firmly to ensure no contour of the collet during die bonding as illustrated in Figure 7. It prevents Warpage of die is experienced during bonding and this results in delamination in the center, between the DAF and bottom die.

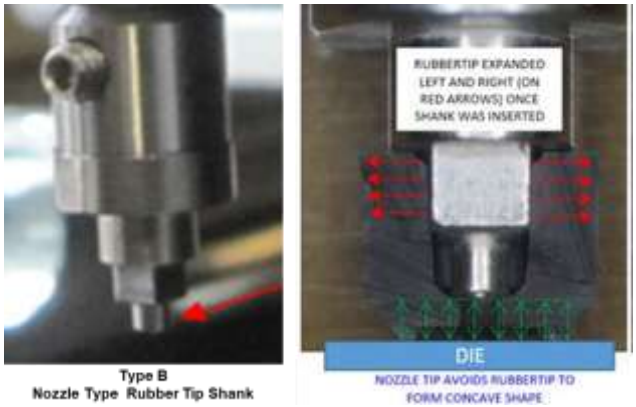

Fig. 7. Nozzle Type Rubber Tip Shank

SAM comparison analysis result shows as shown in Figure 8, Voiding or delamination can be minimized through the use of new Nozzle Type Rubber tip design is tooled up to prevents die warpage problem and eliminate the delamination or DAF voids between die interface concurrently. All the delamination free units have been submitted to reliability testing. The result shows that all the units have passed IPC/JEDEC MSL3. In summary, this study demonstrates that good processibility and robust performance with DAF can be achieved with Die Attach tooling selection and optimized process parameters. Based on the results, it is highly recommended to use the Nozzle Type Rubber tip shank.

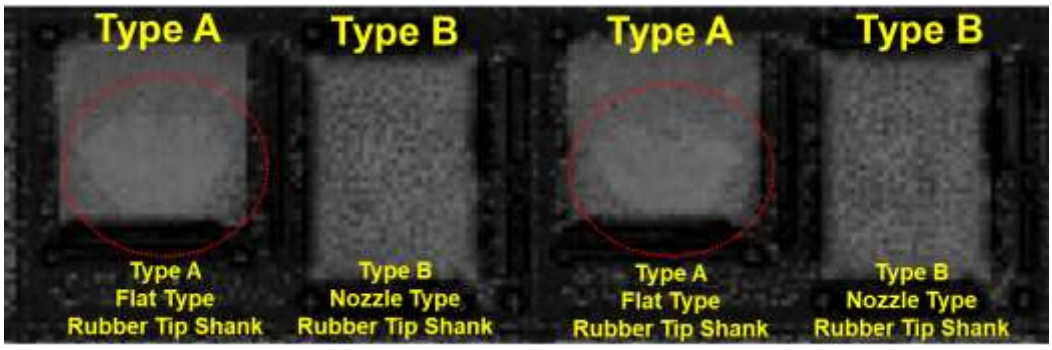

Fig. 8. SAM Photo of DAF Voids Comparison of 2 Types of Rubber Tip Shank

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

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