



# A Study of Die Shear Test Performance on Different Diebond Machine Platforms

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read, reviewed, and approved the final manuscript.

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## ABSTRACT

The paper focused on the evaluation of quad-flat no-leads single-row (QFN-sr) leadframe package for die shear test performance on different diebond machine platforms. Die shear test determines the adhesion strength on the interface between the silicon die and the die attach glue to the diepad of the leadframe device. Moreover, the test is critically monitored as failed response may lead to die lift or delamination. Statistical results showed the two diebond machines achieving die shear test performance above the specification, with Machine Y having significant improvement over its counterpart. Future works could utilize any of the two diebond machines platforms as far as die shear test performance is concerned. For devices with critical requirement, Machine Y is recommended for its higher die shear test performance capability.

**Keywords:** Diebond process; die shear test; assembly manufacturing; leadframe.

## 1. INTRODUCTION

Tapeless leadframe packaging technology is continuously developed and improved to deliver

high quality and robust products for various applications. Examples of semiconductor package that utilize the tapeless leadframe technology are the quad-flat no-leads single-row

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(QFN-sr) and multi-row (QFN-mr) packages. With new and continuous technology trends and breakthroughs, challenges in assembly manufacturing are inevitable [1-4]. In this paper, QFN-sr leadframe device in Fig. 1 is identified to be critical due to certain assembly issues encountered at diebond process. One critical test to check the robustness of the device after diebond process is the die shear test. The test determines the adhesion strength or performance of the silicon die to the diepad of the leadframe device. In this study, the device is evaluated on two different diebond machine platforms for its die shear test performance.

## 2. LITERATURE REVIEW

A full process flow for QFN-sr device is shown in Fig. 2 highlighting the assembly process in focus. Worthy to note that assembly process flow varies depending on the product and the technology [5-7].

Diebond process is the method of attaching a silicon die or multiple dice on a leadframe carrier. The method of attaching the die to a carrier is formed using the sequence: 1) the ejector needle ejects up the semiconductor die from the wafer tape; 2) the rubber-tip picks the die from the needle; 3) the picked die is placed on the already

dispensed leadframe; 4) the bonding height is determined by the bonding parameter together with the dispense configuration. Glue diebonding uses the epoxy glue as the main adhesive to attach the die. The dispensing of glue on the pad of leadframe is done using a volumetric type dispenser. Based on the standard operating procedure, the shaped and condition of the glue is determined by the interaction of dispensing parameter, indirect material and glue type.

Die shear test is critically monitored as this may lead to die lift or delamination. Delamination in semiconductor packages often happens in many interfaces within the package itself, which is mainly caused of the coefficient of thermal expansion (CTE) between interfaces of two materials within the package [8]. Die and/or die attach delamination in QFN-sr is the separation of die attach adhesive to silicon die and Die shear test is critically monitored as this may lead to die lift or delamination. Delamination in semiconductor packages often happens in many interfaces within the package itself, which is mainly caused of the coefficient of thermal leadframe diepad. Die attach delamination would reduce the total contact area of silicon die to the diepad and would increase the package thermal resistance that could lead to early thermal shutdown of the device.

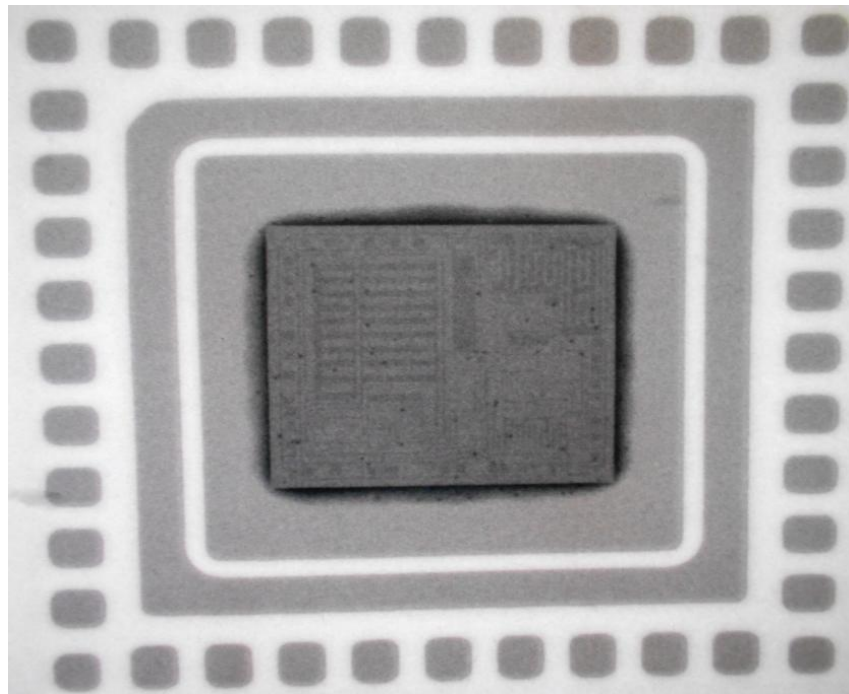


Fig. 1. QFN-sr device x-ray image

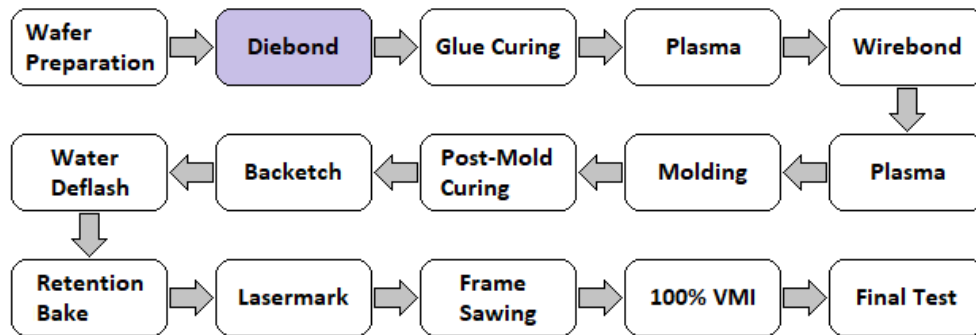


Fig. 2. Assembly full process flow highlighting the process in study

### 3. METHODOLOGY

The QFN device was evaluated on two different diebond machine platforms for die shear test performance. Die shear test is governed by process control specification with minimum requirement depending on the die size and die attach material [9]. Diebond Machine X can provide a die attach glue thickness of only less than 25  $\mu\text{m}$  with a dispensing technology of volumetric dispense. Diebond Machine Y from different supplier is designed to achieve higher die attach glue thickness with a pneumatic dispensing technology wherein the

volume of epoxy could be controlled through pressure. The data gathering flow is defined in Fig. 3.

### 4. RESULTS AND DISCUSSION

The die shear test is one of the critical tests to check the adhesion of the die attach material to the silicon die and lead frame or substrate. Furthermore, die shear is a destructive test to check the mechanical performance of the adhesion. Statistical results in Fig. 4 shows the die shear test performance of the device on the two diebond machine platforms.

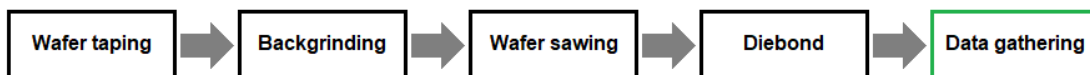


Fig. 3. Data gathering flow

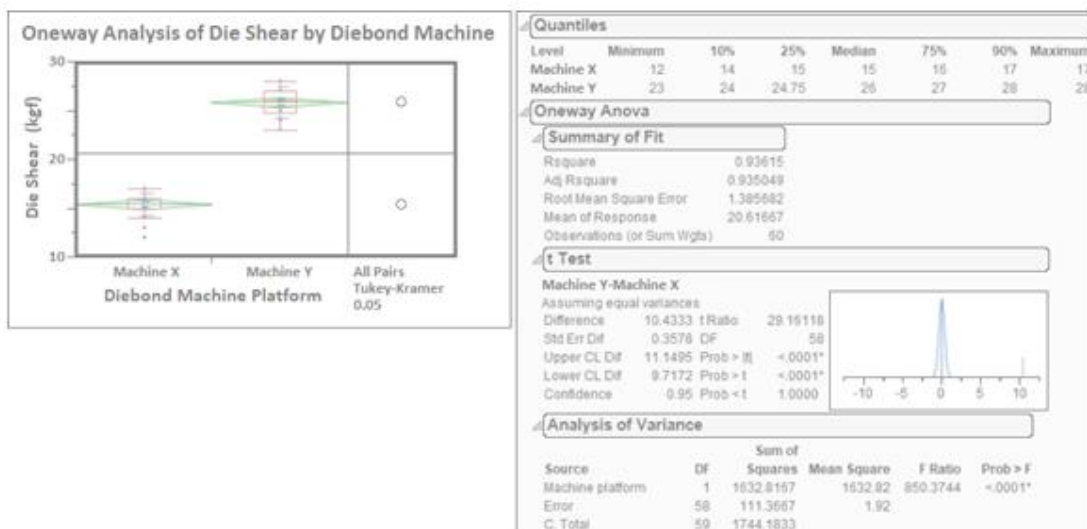


Fig. 4. Statistical analysis of die shear test on two diebond machines

The two machines achieved values greater than the lower specification limited computed for die sizes of less than or equal to 8 mm<sup>2</sup>. Although both two machines passed the die shear test performance, a significant difference between the two diebond machine platforms is observed. Machine Y achieved significant die shear improvement with mean of 26.42 kgf in comparison to that of Machine X with mean of 16.23 kgf.

## 5. CONCLUSION AND RECOMMENDATIONS

The paper discussed the evaluation of different diebond machine platforms on the die shear test performance of QFN-sr device. In this study, it has been shown that both diebond machines passed the die shear test requirement. Furthermore, Machine Y showed significant improvement in the die shear test performance over its counterpart. Higher die shear test performance implies better and stronger adhesion between the silicon die and the leadframe diepad, and ultimately eliminating die lift or delamination.

Future works and studies could use any of the two machines as far as die shear test performance is concerned, with Machine Y recommended for critical devices with stricter requirement. A comparison of this study should also be made with other works in the same field. A study on volumetric dispense versus pneumatic dispensing technology could also be explored, with focus on different dispense methods to deliver higher die shear force. Works and learnings shared in [2,8,10] are helpful to improve the assembly processes specifically the diebond process.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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