Silicon Die with Integrated Epoxy for Improved Interface Adhesion

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ABSTRACT

Breakthroughs and innovations are constantly being developed in electronic packaging industry to address the manufacturing challenges and overcome existing assembly limitations. An augmented design of thin Silicon die is introduced to establish a robust and improved interface adhesion between the die and the die attach material during the die attach process. The wafer preparation flow is also presented. The realization of the augmented die design with integrated epoxy material would ultimately provide a robust connection and would mitigate the die attach related issues such delamination, die cracks and voids.

Keywords: Adhesion; delamination; die attach process; glue; epoxy; silicon die.

1. INTRODUCTION

Silicon die-related issues such as the die delamination, die cracks, and die attach epoxy voids occur specifically on thin die applications during the die attach process. An image in Fig.1. captured using scanning electron microscope (SEM) shows the cross-sectional view of a
delamination between the die and the glue die attach material.

Die delamination in an electronic device is the separation of the die attach material to the Silicon die. A small delamination when aggravated may worsen and propagate resulting to a complete delamination of the die to the glue. Delamination may also propagate to other interfaces inside the quad-flat no-leads (QFN) package, for instance the die-to-carrier, mold-to-die or mold-to-carrier interfaces. With the growing demand on thin die applications, elimination of die and die attach related issues is one significant challenge during wafer preparation and the die attach process.

2. DESIGN SOLUTION

The formation of the glue fillet height on the sidewall of the die is a normal response of the glue or epoxy when a die is attached. A new Silicon die design with integrated epoxy shared in Fig. 2. would provide a natural adhesion to the succeeding glue or epoxy material during the die attach process.

Silicon die bottom side backside area is augmented with the pre-applied epoxy die attach material on the grooved periphery. With the integrated epoxy material, the die attach coverage is enhanced and the die attach adhesion is reinforced and becomes more robust. The new die design offers a potential solution to eliminate the delamination formed between the interface of the die and die attach material during the die attach process. Fig. 3. illustrates the updated wafer preparation flow to reflect the added steps specific for the new die design with integrated epoxy material. Laser grooving technology is used in the formation of the peripheral groove.

As earlier mentioned, the augmented die design with integrated epoxy material could help mitigate die to die attach delamination. Lower coefficient of thermal expansion (CTE) mismatch is also created between the pre-applied epoxy material and the subsequent die attach material. Fig. 4. shows the cross-sectional representation of a QFN leadframe device using the new Silicon die design with integrated epoxy material, highlighting the adhesion interface between the two die attach materials. Furthermore, die cracks could be prevented and die attach voids could be minimized with the application of the new design.

![Fig. 1. SEM photo of silicon die interface with glue](image1.png)

![Fig. 2. Silicon die with integrated epoxy 3D view](image2.png)
3. CONCLUSION

The paper presented a new Silicon die design with integrated epoxy die attach material for establishing a robust interface with the subsequent die attach material. With the improved design, die attach delamination issues as well as die cracks and die attach voids could eventually be mitigated. Future works could use the new die design to realize a robust die attach process and prevent any die attach related assembly issues. For references, works shared in [1-5] are helpful in tackling delamination issues. Studies and learnings discussed in [6-12] are useful to address other die attach related challenges.

DISCLAIMER

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

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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