International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

A Practical Study of the Effect of Vacuum Hole Design of Rubbertip in the Manufacturability of Thin Silicon Technology

Rennier S. Rodriguez, Frederick Ray I. Gomez
Central Engineering and Development – NPI, Back-End Manufacturing & Technology, STMicroelectronics, Inc.
Calamba City, Laguna, Philippines 4027

Keywords**—** *Die bond; rubbertip; die attach; semiconductor; pick and place; process improvement.*

I. Overview

Rubbertip or often called pick-up tool (PUT) in Fig. 1 is a material essential for die attach film (DAF) pick and place process wherein it is used to hold the ejected silicon die from the wafer tapes prior transfer to a carrier substrate.

Fig. 1. Example of common rubbertip material used in integrated circuit assembly.

The material is integrated in the pneumatic controlled system inside the diebond equipment. A cycle of vacuum is supplied to the pick assembly when holding the ejected silicon die and de-activate the vacuum supply upon reaching the place position.

II. Scope of the Study

Thinning requirement on silicon die opens up the window for the breakthrough of miniaturized integrated circuit assembly. However, there are different assembly challenges identified associated with the thinning requirement. This study includes the effect of different pick-up tool configuration on thin silicon die during DAF pick and place process. The quality of attached silicon die with reference to the condition of the pick-up tool design is also included in this study.

III. Design of Experiment / Methodology

The contact surface of the pick-up tool became the interest of the study due to its potential significance in the quality of bonded silicon die. Two different contact surface design of pick-up tool material is evaluated in this experiment. The first pick-up tool in Fig. 2 has a larger vacuum hole design with relief type corner support. The second material is with smaller vacuum design and full contact surface.

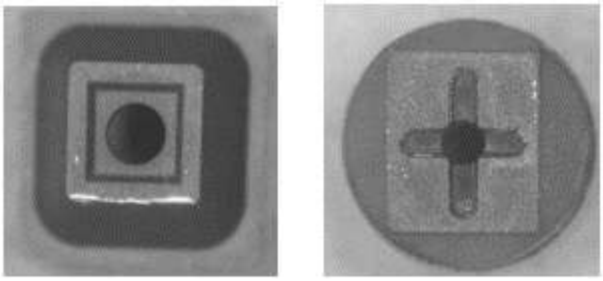

Fig. 2. PUT with larger vacuum hole and relief type corner support design (left). Smaller vacuum design and full contact surface (right).

Design of experiment is done to measure each material according to its actual response in terms of picking and bonding capability.

IV. Result and Discussion

The two sets of experiment are performed and the result is summarize in Table 1.

Table 1: Summary of result.

Trial	Picking	Bonding
PUT#1 Larger vacuum hole and relief type corner support design	Failed Remarks: With occurrence of die crack	Failed Remarks: With occurrence of voids
PUT#2 Smaller vacuum design and full contact surface	Marginal Remarks: With occurrence of miss-picked die	Passed

PUT with larger vacuum hole design is found in this experiment to fail both pick and bonding requirement while a smaller vacuum design meets both criteria. However, a miss-picking of silicon die is encountered during the experiment but it was treated as a minor defect since it does not affect the functionality of the die.

The die crack defect occurrence on PUT#1 is observed to be related in the alignment of the vacuum hole and ejector needle assembly in Fig. 3.

Rennier S. Rodriguez and Frederick Ray I. Gomez, "A Practical study of the effect of vacuum hole design of rubbertip in the manufacturability of thin silicon technology," *International Research Journal of Advanced Engineering and Science*, Volume 4, Issue 3, pp. 206-207, 2019.

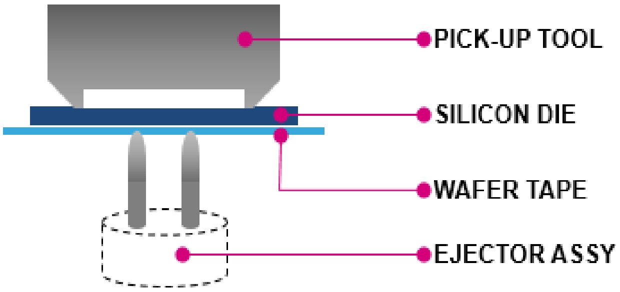

Fig. 3. Illustration of the location of vacuum hole and ejector needle for PUT#1.

During pick sequence, the ejection of the needle is not supported proportionally by the vacuum design of PUT#1 leading to induce deformation of the silicon die during the pick sequence. The deformation in silicon at die level is found to be the cause of die crack occurrence due to the locality of defect consistently propagating from the needle location. In addition, the voids occurrence for PUT#1 in Fig. 4 shows a correlation with the location of vacuum hole design of the material. The locality of the voids is evident on the middle area wherein a deformation in the silicon die take place.

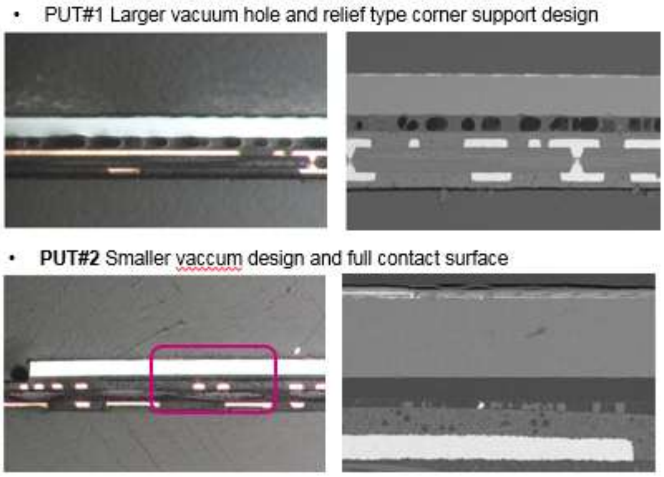

Fig. 4. Captured photo of voids for PUT#1 (top) and PUT#2 (bottom).

With the comparison of the two actual materials, the bonding quality is better with the pick-up tool with reduced vacuum hole.

V. Conclusion and Recommendation

The thinning of silicon die requires adjustment in the current design of rubbertip or pick-up tool material wherein the vacuum hole and effective contact surface should be balance effectively. Decreasing the vacuum hole and increasing the contact surface of the pick-up tool material improves the manufacturability of thin silicon die material during pick and place process.

This study is recommended to be considered as a reference when handling thin silicon die technology and the transition of packages to miniaturization.

References

[1] ESEC 2008 diebonder machine operations manual.
[2] Huang, HH, Wey J. Research on the high-speed pick and place device for die bonders. 8th IEEE International Conference on Control and Automation, vol. 2, issue 2; June 2010.
[3] Abdullah Z, Vigneswaran L, Ang A, Yuan GZ. Die attach capability on ultra thin wafer thickness for power semiconductor. 35th IEEE/CPMT International Electronics Manufacturing Technology Conference; November 2012.
[4] Kahler J, Heuck N, Stranz A, Waag A, Peiner E. Pick-and-place silver sintering die attach of small-area chips. IEEE Transactions on Components, Packaging and Manufacturing Technology, vol. 2, issue 2; February 2012.
[5] SAS Institute Inc. JMP statistical discovery software. https://www.jmp.com/en_ph/software.html

Rennier S. Rodriguez and Frederick Ray I. Gomez, “A Practical study of the effect of vacuum hole design of rubbertip in the manufacturability of thin silicon technology,” *International Research Journal of Advanced Engineering and Science*, Volume 4, Issue 3, pp. 206-207, 2019.