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Optimization of Dispensing Parameter to Speed up the Die Attach Throughput

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Driven by the company vision to become a high-volume manufacturing (HVM), increasing throughput in the manufacturing line is critical to meeting market demands. The ever-growing demand for integrated circuits in part requires additional capital investment to purchase new equipment such as die bonders to support the new requirement. Making the best of existing resources is often the most common approach to deal with this challenge. Defining the correct method and making the most of the secondary parameters necessary to increase the bonding speed by means of a creative analysis that made this article interesting. The objective of this project is to boost productivity by maximizing UPH to improve the epoxy writing process at Attach, which is a bottleneck area. Optimization of the dispensing sequence and the dispensing direction to improve and speed up the epoxy dispensing process unit per hour.

Keywords: Die attach; dispense sequence; dispense direction; epoxy dispense; unit per hour.

1. INTRODUCTION

In back-end semiconductor manufacturing, the die attach process is a critical step. At first glance, die attach seems to be a simple process step in the semiconductor manufacturing chain. However, the continuously increasing requirements of today's applications set high standards in die bonding [1-5]. The die bond process is one of the critical processes in

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semiconductor manufacturing and one of the bottleneck station. Improvements in mechanical indexing, motor speeds, and processing times have been made.

The most commonly used types of die attach is epoxy, possibly used by 70 to 80 percent of manufacturers today [6-8]. However, as the entire scope of packaging changes to meet increasing demands for higher accuracy, greater speed, the ability to handle small die, the ability to handle a variety of substrate types and the need to address technology challenges, die attach is advancing.

The epoxy bond is formed by attaching the die to the leadframe using epoxy glue. A drop of epoxy is given to the package and the die is placed on top of it. The package needs to be heated at an elevated temperature to ensure that the epoxy is properly cured [9-11]. Epoxy Dispensed by dispensing the needle or the nozzle by controlling volume on the leadframe. The location of the dispensing is controlled by a vision control system in a die attach equipment.

In most cases, the adhesive dispensing pattern is designed so that when the die (adhesive) is placed over the adhesive and the pressure applied, the adhesive is pressed out without trapping the air. The standard pattern is selected automatically based on the X & the Y size of the chip.

UPH is Units per hour or Machine Speed is calculated based on total units' output per hour. Driving package costs down and, as a result, equipment suppliers are expected to provide improved performance machines, as die bond speed has a direct correlation to the cost of a package [12-15]. The faster the machine, the lower the capital equipment depreciation cost is attributed to the package.

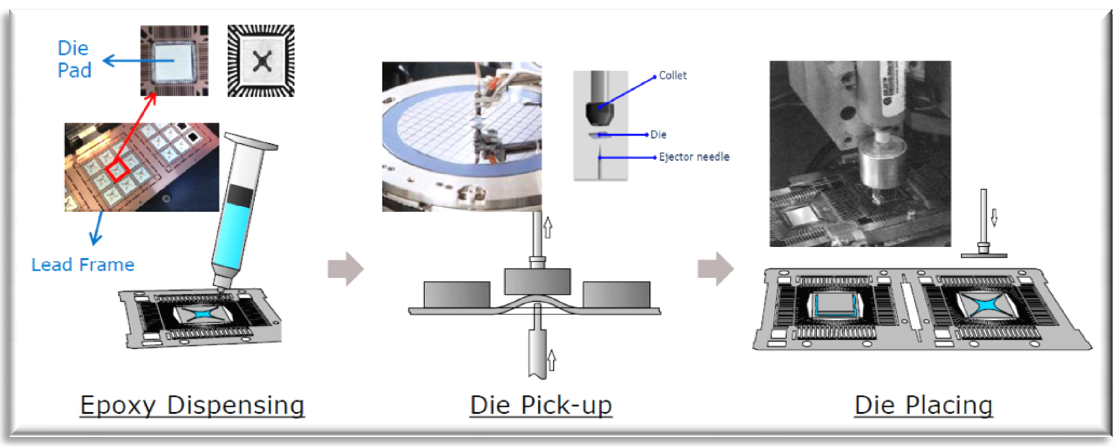


Fig. 1. Die attach process

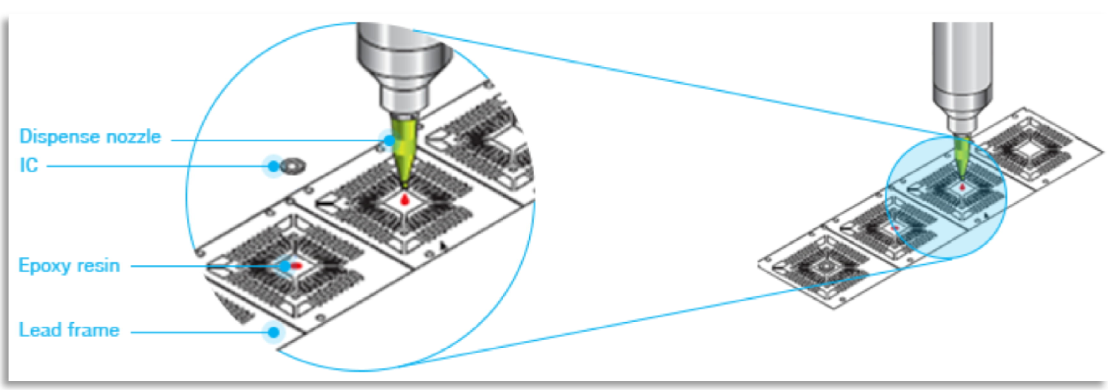


Fig. 2. Epoxy dispense

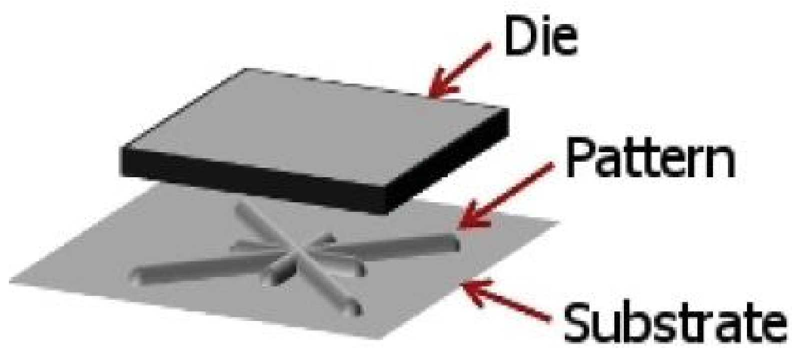


Fig. 3. Epoxy dispense pattern

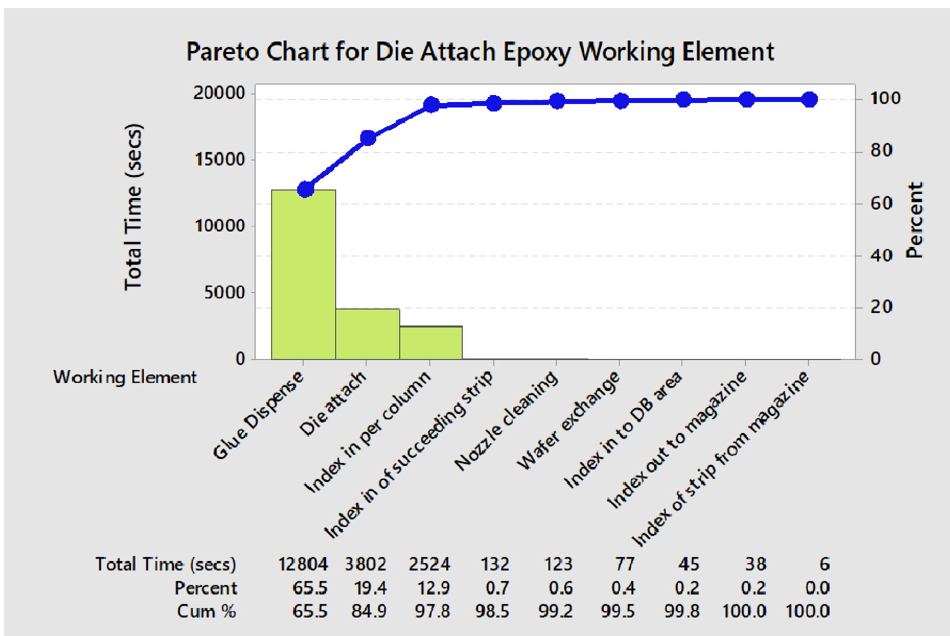


Fig. 4. Die attach working element

Dispensing Patterns can vary from simple dot dispensing for small die (<5 mm on a side) to complicated patterns of lines for large die as shown in Fig. 2 (>20 mm on a side). The challenge for larger die is to have the adhesive spread to assume the shape of the die during the die placement process. There are many approaches to this problem and it can consume considerable process engineering time for critical applications.

Base on the Die Attach Epoxy working element at 65.5% of the total time processing is on epoxy or glue dispense. The focus of this study is on how to increase the actual Glue Dispense speed. To increase capacity by as much as 20% with zero investment, is through maximizing indexing and motor speed, and Optimize the dispensing method to reduce processing time. All were done with utmost consideration of product quality.

2. EXPERIMENTAL DETAILS

The first experiment for the dispensing of epoxy is to evaluate a different dispensing sequence or mode for the dispensing of epoxy writing. To achieve the best for the big die bond quality at the highest throughput, below are the 2D rheological simulations that can be investigated. Different dispensing sequences of X patterns, 8 sequences and 6 sequences have built a 2D model to investigate and to study their effect on machine's dispensing speed and UPH.

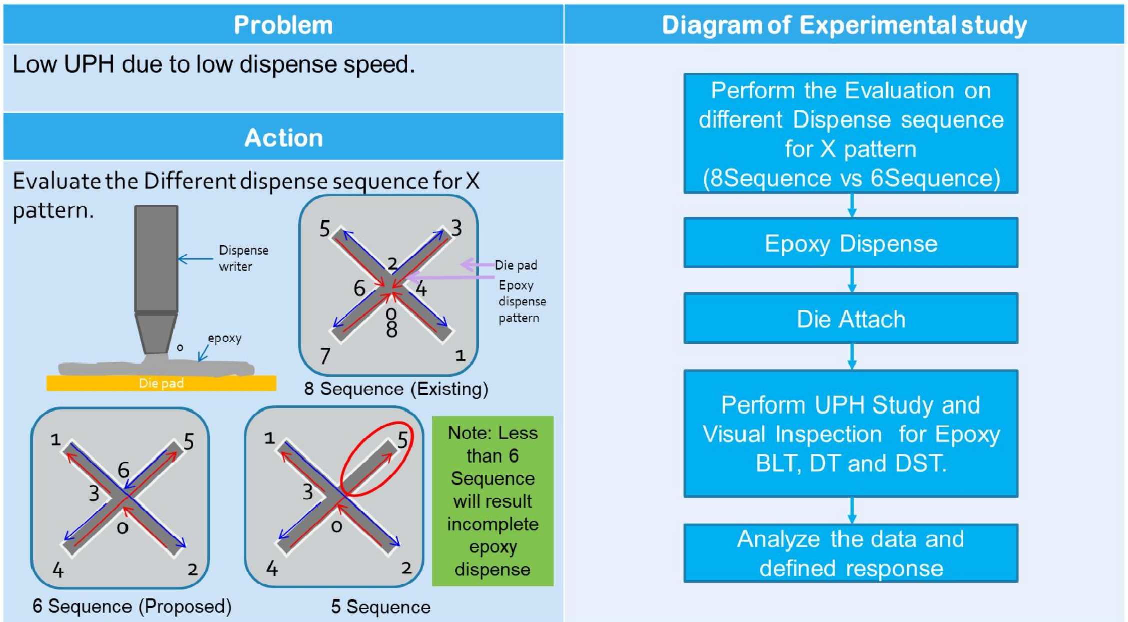


Fig. 5. Epoxy dispense sequence for X pattern evaluation

The second evaluation is in the direction of dispensing during epoxy dispensing. There are different approaches to the dispense direction, the first is the existing Ascending Y direction and the second is the Alternative Y direction which is proposed for this study. Which dispensing direction will give higher speed and UPH is dispensed to the machine.

3. RESULTS AND DISCUSSION

After the completion of the evaluation, statistical validation was carried out using 2 Proportion tests to check the effectiveness of the actions. The first statistical validation is for the dispensing sequence of X patterns, 8 sequences, and 6 sequences. The statistical result is shown at a

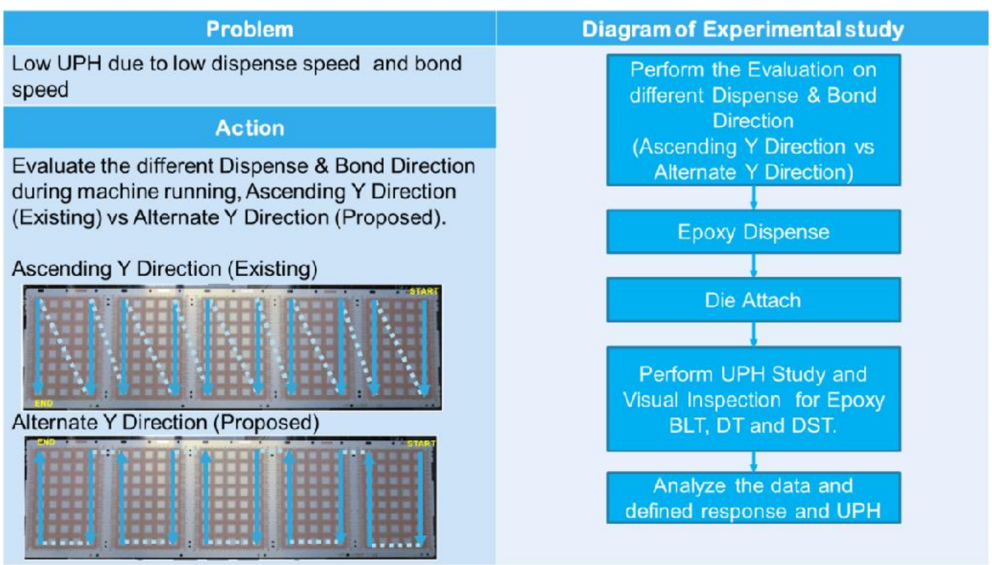


Fig. 6. Epoxy dispense direction evaluation

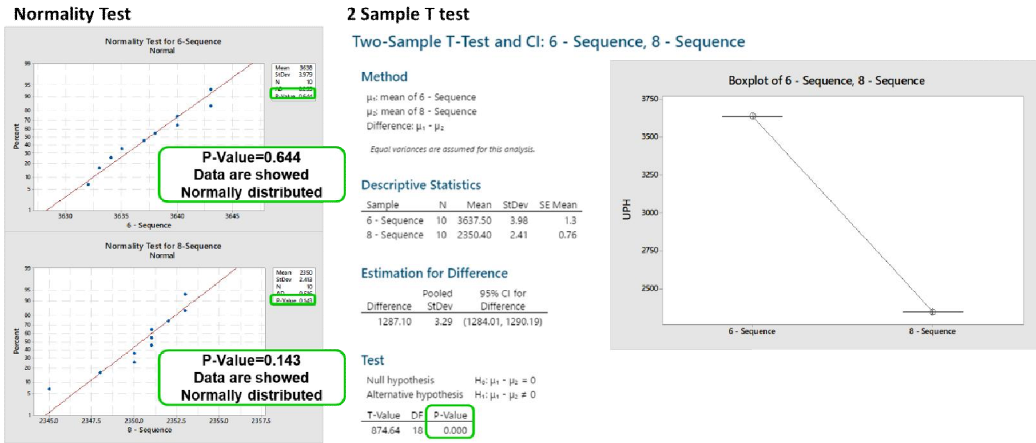


Fig. 7. Epoxy dispense sequence statistical validation result

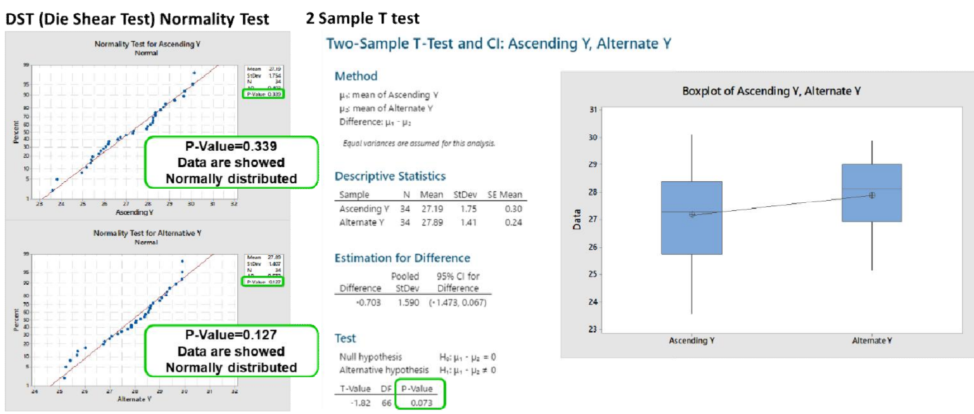
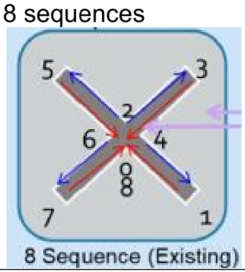
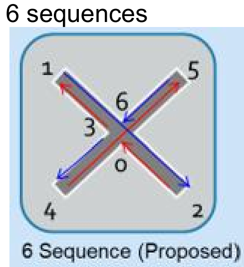
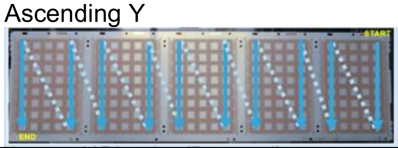
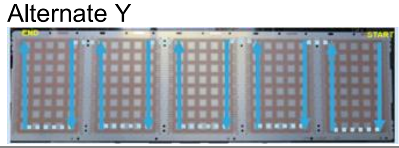


Fig. 8. Epoxy dispense direction statistical validation result

Table 1. Summary of improvement

Parameter	From	To
Dispense sequences	8 sequences 	6 sequences 
Dispense Direction	Ascending Y 	Alternate Y 
Dispensing Time	594 ms	420 ms
Machine UPH	2037	2514

95% confidence level that there is a significant difference between 8 sequences and 6 sequences in terms of the UPH response. 6 sequences show higher UPH or output compared to 8 sequences. It shortens the distance or speeds up travel time to generate an X pattern.

The second Statistical validation was performed thru the direction of dispensing during epoxy dispensing. Using statistical 2 Proportion tests it was shown at a 95% confidence level, there is a significant difference between Ascending Y direction and Alternate Y direction in terms of UPH or speed in dispensing. Alternate Y direction showed higher UPH due to shorter travel time to complete the dispensing for the entire leadframe.

Implementation of both the Dispense parameter; the Dispense sequence of 6 and the Alternate Y dispensing direction will reduce the dispensing time from 594 ms to 420 ms, this will result in a 23% improvement of the Attach UPH from 2037 UPH to 2514 UPH.

4. CONCLUSION

Optimizing the speed and time of the equipment beyond the usual settings to test the limits of the process. New standards have been established in the Die attach process. The proper definition of critical speed parameters and methods will increase additional capacity. The most significant parameters for increasing the speed of dispensing of die bonders are the dispensing sequence and dispensing direction. These parameters are often neglected during programming and setup, but with proper evaluation of the machine parameter, the goal can be achieved.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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