Journal of Engineering Research and Reports

20(6): 109-114, 2021; Article no.JERR.68229
ISSN: 2582-2926

A Robust Approach of Maintaining Epoxy Position on Die Attach Process of Tapeless QFN Packages

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Authors' contributions

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

Article Information

DOI: 10.9734/JERR/2021/v20i617333
Editor(s):
(1) Dr. Guang Yih Sheu, Chang-Jung Christian University, Taiwan.
Reviewers:
(1) Polphat Ruamcharoen, Songkhla Rajabhat University, Thailand.
(2) Siti Khatijah Binti Jamaludin, Universiti Teknologi MARA (UiTM), Malaysia.
(3) Tan Wei Hong, Universiti Malaysia Perlis (UniMAP), Malaysia.
Complete Peer review History: http://www.sdiarticle4.com/review-history/68229

Original Research Article

Received 02 March 2021
Accepted 08 May 2021
Published 10 May 2021

ABSTRACT

Epoxy quality contributes a great role in defining quality products of quad flat no lead multi row packages. In dealing with certain problems related to epoxy position shift caused by unoptimized design, innovation on the dispenser module is considered and focused at. This paper discusses the phenomenal issue of epoxy position shifting in die attach process and the solutions applied. The current design of dispenser module in die attach machine demonstrates flaws that need to be improved through design optimization. Innovative approach was applied, removing variables on the design that caused rejections during die attachment due to the shifted epoxy position. The improved design was able to address the issue as projected on the study, and helps not only the epoxy position performance, but also the set-up time of epoxy during syringe replacement. This design can be adapted by other manufacturing for process improvement and robustness.

Keywords: Die attach process; epoxy dispense module; epoxy position; QFN multirow.

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1. INTRODUCTION

Certain challenges are inevitable in semiconductor manufacturing of quad-flat no-leads multirow (QFN-mr) packages. Innovation and improvement play a significant part in obtaining process stability, robustness, and unparalleled quality performance. Machine capability and process performance are measured respectively as these are the variables needed to consider and focused at.

On die attach process of QFN-mr wherein singulated dice are picked from silicon wafers and placed on a leadframe using epoxy as die attach material, epoxy position is being considered as one of the critical aspects of this process. It was defined firsthand by product designers to meet the product requirement such as bond line thickness and epoxy area coverage, and may result to unit rejection if violated, or not maintained. Epoxy related defects such as epoxy fillet build up or incomplete area coverage will be most likely to happened if epoxy position is not in line with the die during die attach process. One factor affecting this phenomenon is the epoxy writer module performance during dispensing of epoxy, particularly on how consistent it hits the target position as defined during machine setup and acceptable process capability to sustain product quality.

On this die attach machine epoxy configuration, epoxy syringe (determined using 30cc syringe) is attached directly on the epoxy writer and mounted altogether on the dispenser module arm as shown in Fig. 1 during dispensing on a leadframe pad, strong vibration occur that cause the epoxy shift on defined epoxy position. This is because of the weight of the epoxy syringe that affects the movement of the epoxy writer. Syringe filled with epoxy attached to the writer and dispenser module arm adds irrelevant weight and affects dispensing quality of epoxy pattern. This current design of the dispenser module projects certain flaws that needs further improvement, especially in robustness of process and capability of producing quality products.

2. METHODOLOGY

Epoxy setup on die attach process is considered as one of the critical technical aspects of the machine setup procedure. Epoxy parameters are defined initially prior of placing the die, to achieve an acceptable die attach structure and criteria. This includes epoxy position with respect to die placement on the pad. Performing epoxy position setup on die attach machine includes vision system and parametric. Die attach machine uses vision setup called pattern or photo recognition system (PRS) that recognizes the die pad area to be dispensed by epoxy. Other works and studies related to PRS can be found in [1-7]. The die attach machine's PRS will detect the pad perimeter and calculates the desired position of the epoxy. Default position is at the center of the pad unless otherwise offset position is required by the product and will be managed by parameter settings. Offset values will be encoded by the user in mils or millimeter unit of measurement, and the machine will auto calculate the position during dispensing. Similar procedure on bonding process is performed on the die pad area to achieve desired die placement.

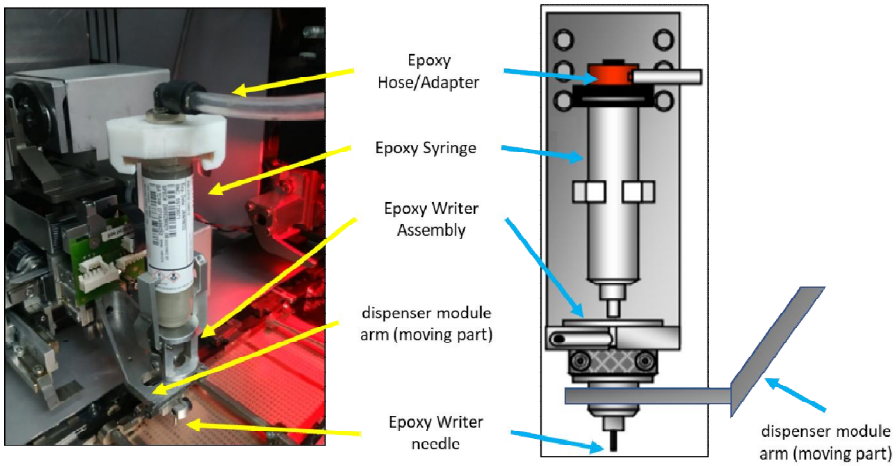


Fig. 1. Dispenser module assembly of die attach machine

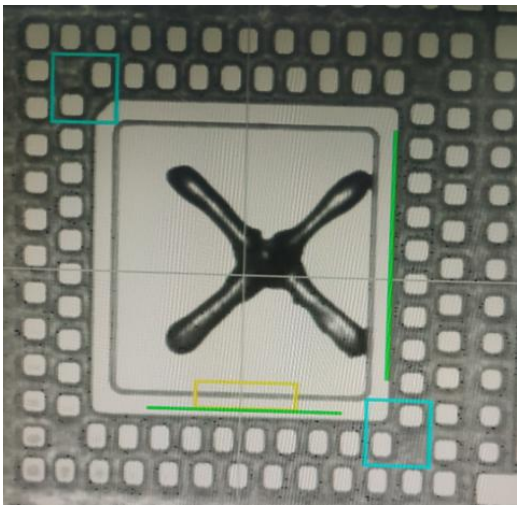


Fig. 2. Epoxy position shifted to the right

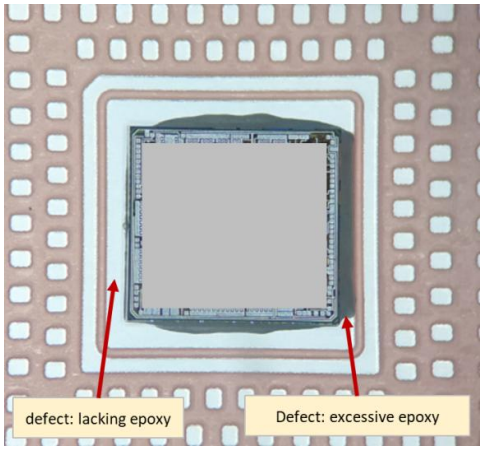


Fig. 3. Epoxy related defects caused by epoxy shifting

As highlighted in Figs. 2 and 3, respectively, epoxy position initially defined on the center of the pad had shifted on one of the sides randomly on leadframe pads and resulted in reject units caused by epoxy related defects. To eliminate the said phenomenon, a practical approach on the design will be considered to have an improved manufacturing process.

3. RESULTS AND DISCUSSION

A design modification on the epoxy dispenser module had been performed and executed to enhance the epoxy process and eliminate the phenomenon of sudden epoxy position shift caused by weight dragging of the syringe. To eliminate the irrelevant weight, the syringe must be removed from the moving part of the dispenser. It has been strategically relocated and fastened on the upper part of the dispenser module through a fabricated syringe holder with interlocking threaded design for syringe replacement as illustrated in Fig. 4. To maintain the flow of epoxy during dispensing, a plastic tubular hose is connected between the syringe and the dispenser needle. It will serve as extension that interconnects the source of the material to the moving part of the epoxy writer. Therefore, it will eliminate irrelevant weight that drags the movement of it. The design does not alter or disturb the electronic connections of the dispenser module, instead introduced an innovative approach to let the module performs robustly and effectively.

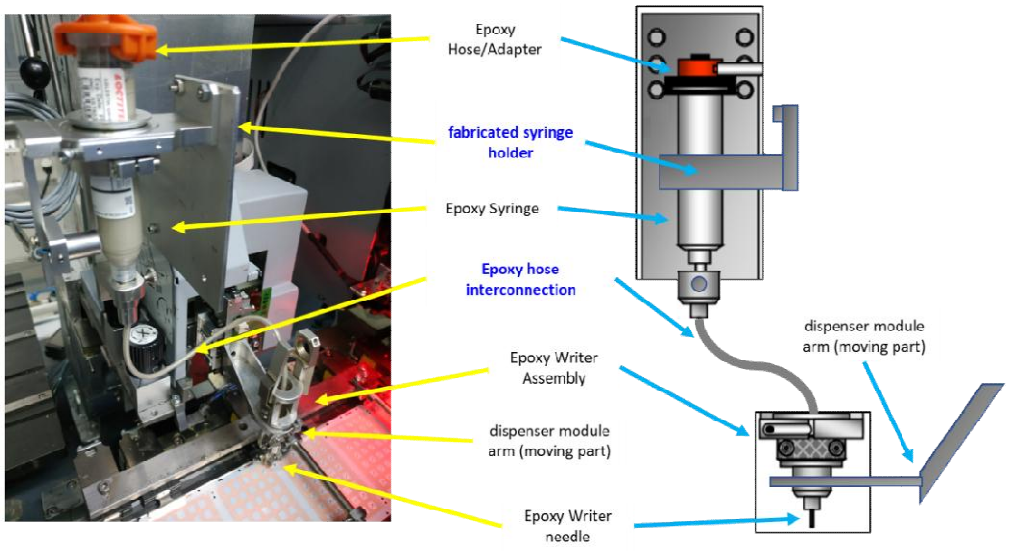
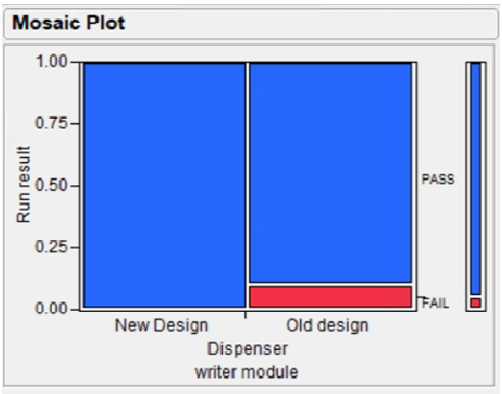


Fig. 4. New design of dispenser writer module



Tests

N	DF	-LogLike	RSquare (U)
160	1	5.7558011	0.1812

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	11.512	0.0007*
Pearson	8.421	0.0037*

Fisher's Exact Test	Prob	Alternative Hypothesis
Left	0.0033*	Prob(Run result=PASS) is greater for Dispenser writer module=New Design than Old design
Right	1.0000	Prob(Run result=PASS) is greater for Dispenser writer module=Old design than New Design
2-Tail	0.0065*	Prob(Run result=PASS) is different across Dispenser writer module

Fig. 5. Statistical analysis interpretation using mosaic plot

Experiment was conducted to validate the effectivity of the new design using leadframes with sample units. Data from the sample units processed on the old and new design was gathered and statistical analysis was performed. Using chi square and 2-proportion tests as seen on Fig. 5, analysis shows significant difference between the two, and the new design of dispenser writer module is better compared to the old design.

Aside from the improvement on the process, it also promotes efficient epoxy position setup time after replacing empty syringe by 65%, from 45.3

minutes including epoxy position set up to 15.8 minutes eliminating it. This is due to the epoxy writer needle is already detached from it, retaining its current position ready for another sequence of production run.

4. CONCLUSION AND RECOMMENDATIONS

In this design improvement on die attach machine, epoxy performance by means of targeting desired position has improved significantly. Relieving the moving part from irrelevant weight had resulted to a more improved process performance through this innovative design, and significantly improve throughput gain on man hour epoxy setup time. This manufacturing breakthrough that showed admirable outcome, is highly recommended to apply also on other machines with almost the same or exact design given with appropriate machine capability and product requirements. Ideas through redesigning of parts or related studies of the same concept of design improvement would be of big help in discovering ideas for robustness and optimization of die attach process. References shared in [8-12] would be of big help in discovering ideas for robustness and optimization of die attach process.

DISCLAIMER

The products used for this research are commonly and predominantly used 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.

ACKNOWLEDGEMENT

The authors would like to thank the Operations 1 Assembly Pre-Production Group (PPG) and Equipment teams, the New Product Development & Introduction (NPD-I) team, and the Management Team (MT) for the relentless support.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/68229