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Die Attach Assembly Process Tool Advancement

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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.

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ABSTRACT

Die attach film (DAF) voids detection is one of the challenges during the introduction of non-conductive adhesives for integrated circuit products affecting production control robustness and detection. In this paper, a specialized tool capable to distinguish and quantify the amount of DAF voids is presented wherein the implementation of semi-auto grid lines generates more precise measurement and correct defect call-out. The tool is proposed as an alternative option for x-ray inspection that is found to be incapable in proper detection and accurate measurement of gaps and un-occupied area within the adhesive thickness that produces over estimation of production rejects.

Keywords: Measurement tool; DAF voids; non-conductive adhesives: integrated circuit.

1. INTRODUCTION

Since the discovery of x-ray, it became widely adapted into different field of application and industry such as medical, security, manufacturing, etc. For semiconductor assembly, x-ray is implemented to improve the in-process controls and inspection capability of the production line to detect the assembly rejection such as glue voids and epoxy coverage [1-4]. Moreover, x-ray is a tool that can be used also during the construction and failure analysis of semiconductor units to understand profoundly the condition and integrity of assembled units

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[4-6]. X-ray inspection became popular in semiconductor industry during the introduction of conductive glue material that is used to bond the silicon die to the leadframe thermal pads. When the glue is exposed to the x-ray environment, the area with metal rich portion absorbs the radiation more producing darker feedback to the image while un-occupied areas inside the unit such as glue voids let the radiation to pass through leaving a white coloration to the image.

Through integration of measurement system in the x-ray technology as shown in Fig 1, it became easier for the manufacturing personnel to understand the behavior of the conductive material inside the semiconductor unit and ease production controls through providing precise image and measurement analysis.

The transition of semiconductor devices with non-conductive glues and films restrict the application of x-ray as inspection controls since it is found incapable to detect organic materials such as resins and silica (non-conducive fillers) differences. The material when subjected to x-ray produces similar threshold feedback to the image system making voids and gaps undetectable from areas filled with non-conductive glues. From this scenario, risk of defect escapee became a highlighted issue for production.

2. DESIGN SOLUTION AND IMPROVEMENT

Opportunity arise from the absence of reliable tool that could be implemented as production controls for non-conductive adhesives. On the other hand, it will be an advantage for the implementing body to consider the cost of implementation, as a challenge from the management.

An in-house software tool is developed to be implemented as a reliable measuring tools for non-conductive adhesives. The measuring tool in Fig. 2 for die attach film (DAF) voids is composed of semi-auto grid tool that can quantify the area in a more precise manner through identification of the affected area per grid box.

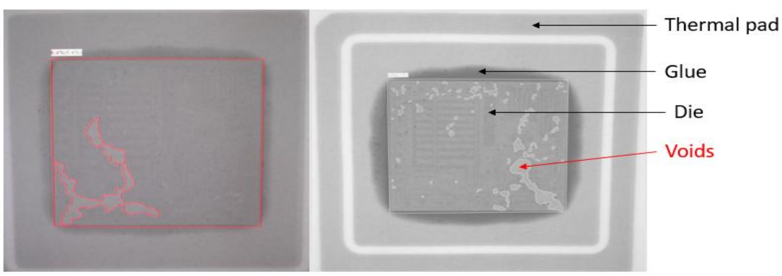

Fig. 1. X-ray image

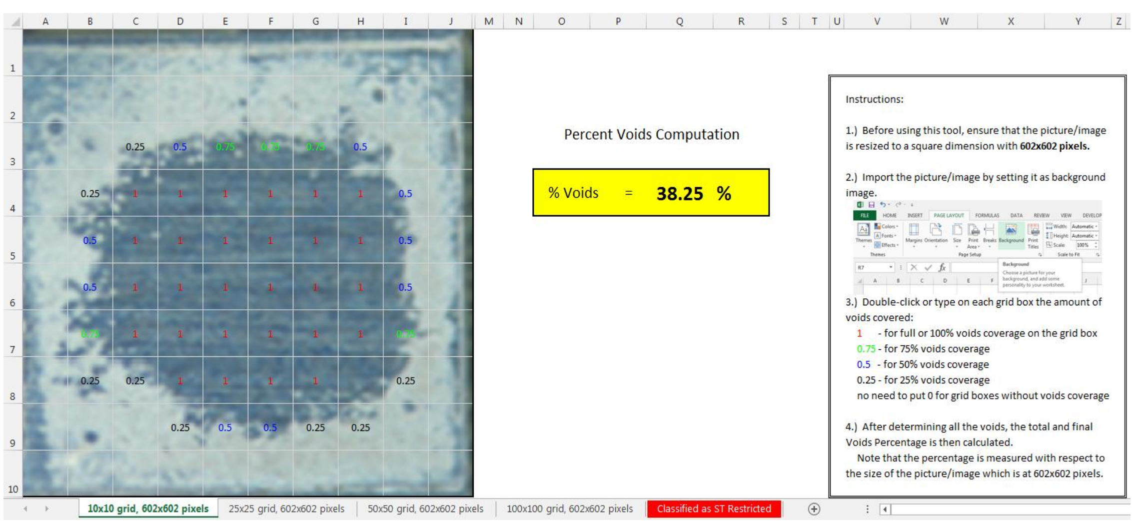

Fig. 2. Semi-auto DAF voids measuring tool

The photo of the unit to be measured is inserted in the software and required to be resized in square or rectangular dimension and required to be in 602x602 pixels. Once the image is imported to the software, it will automatically draw grid lines vertically and horizontally with each box incorporated with measurement counter.

The counter is designed with percentage counter that is determined according to the approximate values of the affected area per box through "*clicking*" with each grid boxes. Each grid boxes are labeled with "0" for not affected area, "0.25" for 25% affected area, "0.5" for 50% affected area and "1" for 100% affected area that will summarize in the "percent voids computation" box. The identification of affected area per grid box is subjective and will depend from the judgement of the personnel measuring the DAF voids however the error of approximation is minimized by increasing the number of grid boxes and the included percentage value inside. For example, the grid boxes can be re-configured to 16x16, 32x32 or 64x64 with each label of 0.1, 0.2 …1.0 (10% - 100% respectively).

Fig. 3 shows the actual result of the evaluation done comparing manual estimation and semi-auto grid tool. Actual result shows that at most the measuring capability can be improve by 7.68% against manual estimation. The specification (or spec) limits are governed by assembly quality specification and work instructions [5,7-8].

Fig. 4 shows the summary of data between manual and semi-auto grid tool, with 7 rejected units determined manually, but the tool verified only 4 of them as rejects. As highlighted in Fig. 4, 5 units are rejected using visual manual grid estimation with normalized spec limit ≤ 15%. However, using semi-auto grid tool with normalized spec limit recorded only 3 rejected units.

Sample	Type of Void	% DAF Voids		Delta
		Visual Manual Grid Estimation	Semi-Auto Grid Tool	
1	Single (spec limit ≤ 5%)	32	38.25	6.25
2		12	13.50	1.5
3		20	22.50	2.5
4	Cumulative (spec limit ≤ 10%)	12	6.76	-5.24
5		8	4.72	-3.28
6		20	20.56	0.56
7	Micro bubble (spec limit ≤ 15%)	12	5.88	-6.12
8		16	8.32	-7.68
9		16	10.56	-5.44

Fig. 3. Evaluation result

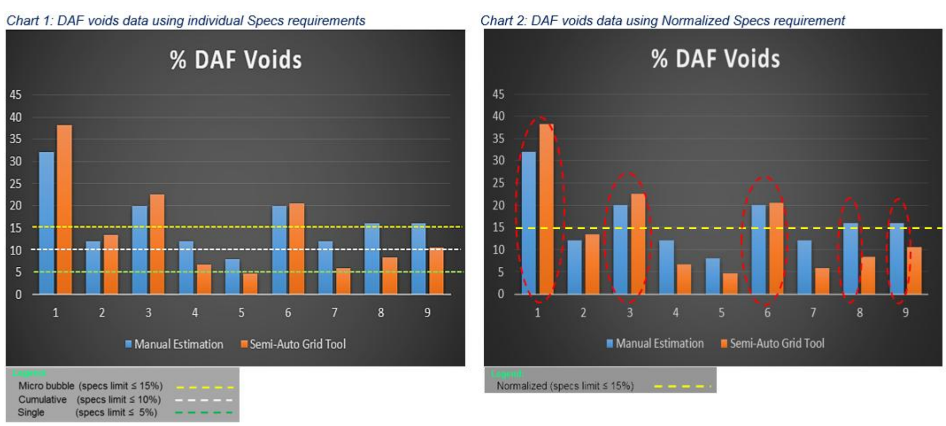

Fig. 4. Graphical summary of results

With the availability of the semi-auto grid tool, assembly process control now has the means to verify and control affected units with DAF voids for non-conductive units. In addition, the semi-auto grid tool can identify the precisely determine the rejected units from good products thus improving the yield and cost as secondary matrix.

3. CONCLUSION AND RECOMMENDATIONS

A specialized software tool is presented in this paper wherein it provides measurement capability for DAF voids on non-conductive adhesives on integrated circuit (IC) devices. Cost-effective implementation was also realized as the semi-auto grid tool utilized existing software licenses and available resources. The measured value using the specialized tool is of better accuracy and credibility than the manual grid visual estimation, with the results for example indicating 7 rejected units using manual estimation but the semi-auto grid tool measured only 4 rejects.

Though this paper focused on the tool and improvement in the monitoring system, it is still important and of top priority that the voids are minimized, if not eliminated. Continuous process improvement is necessary to sustain high quality performance of assembly manufacturing. Discussions and learnings shared in [9-11] are helpful to improve the assembly processes particularly the die attach 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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