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Pick and Place Process Defect Mitigation on Semiconductor BGA Device

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Authors' contributions

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

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ABSTRACT

With the new devices and new technologies in semiconductor industry are getting more challenging to process because of new processes and process bricks. One of the most challenging assembly processes is the pick and place or the die attach process. Issues were encountered during product development phase of a semiconductor ball grid array (BGA) device of radio frequency (RF) applications and one of which is the "thrown" dies during die picking. This paper is focused on addressing the thrown dies issue at pick and place process. Installation of blower ionizer on the machine is an extensive improvement done to eliminate the foreign materials resulting to thrown dies during picking. With this improvement, a reduction of around 80 percent of thrown dies was achieved. For future works, the improvement and learnings could be used for devices with similar requirement.

Keywords: BGA; integrated circuit; pick and place; semiconductor assembly.

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1. INTRODUCTION

Semiconductor ball grid array (BGA) device is one of the mainstay integrated circuit (IC) packages in semiconductor industries assembly manufacturing. The fast pace growth on this package provides the need for every industry to come up with more innovative packaging solutions to stay competitive in the market. However, issues were encountered in pick and place process or die attach process, and these are unavoidable. This paper is focused on the foreign materials or debris of the wafer resulting to "thrown" dies or dies fly-off defect during die picking. Actual photo shown in Fig. 1 pinpoints the signature of foreign materials on the active wafer die. This paper presents an improvement to process this type of technology in pick and place process by adding a blower or ionizer. The blower or ionizer will serve as a fan to remove the foreign materials on the active wafer die of radio frequency (RF) application.

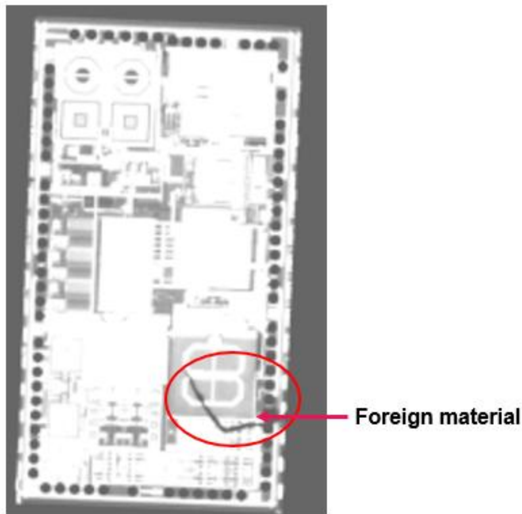

Fig. 1. Foreign material on the active RF die

2. LITERATURE REVIEW AND PROBLEM IDENTIFICATION

A complete assembly process flow for the semiconductor device in focus process starting pre-assembly to singulation process is shown in Fig. 2. Highlighted is the process where the issue was encountered. Worthy to note that assembly process flow varies depending with the product and the technology [1-5]. Also, with the continuing technology development and state-of-the-art platforms, challenges in semiconductor industry are unavoidable [6-10].

Thrown dies occurrence during picking is the top major assembly defect or issue. This is caused by a foreign material located on the top of the IC chip and this foreign material are not detectable by the machine. When the RF die has a foreign material during pick process, the die or chip will not be properly picked, and the chip will be thrown on the neighboring side. Fig. 3 illustrates the phenomena of thrown dies on the actual unit. During picking process, an improvement is done by installing a blower or ionizer near the picking area.

Pick and place is the process of attaching the chip into a carrier or substrate. The method of attaching the chip to a carrier or substrate is formed using the sequence: 1) The ejector pin ejects up the semiconductor chip from the wafer tape; 2) The pick-up tool picks the chip from the needle; 3) The picked chip is placed on the carrier or substrate. Actual pick and place process is shown in Fig. 4.

3. PROCESS DEVELOPMENT SOLUTION AND DISCUSION OF RESULT

With the improved and enhanced process solution in pick and place process is extensively resolved the foreign materials present at the top

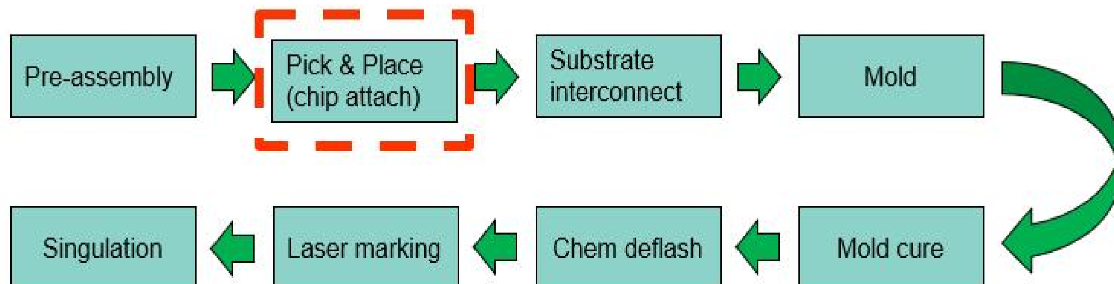

Fig. 2. Semiconductor BGA assembly process flow

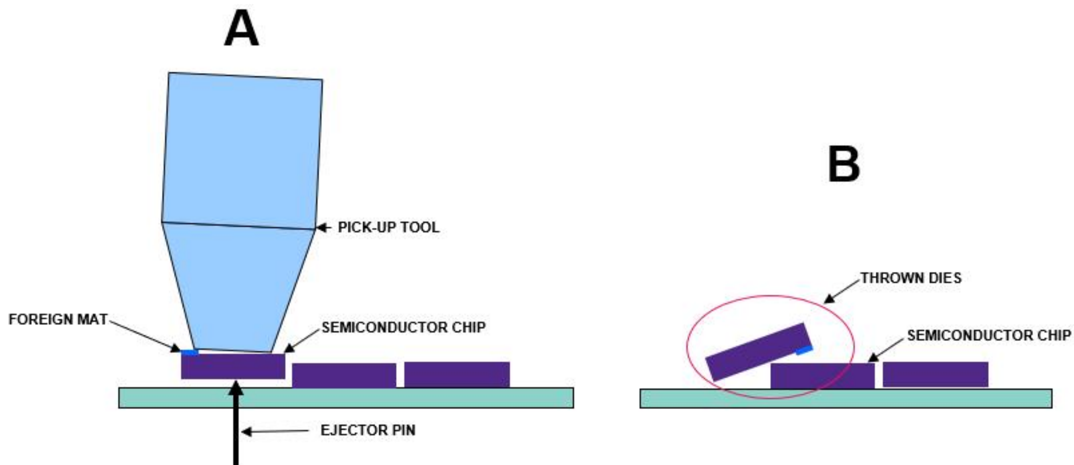

Fig. 3. Actual pick process with thrown dies/chip

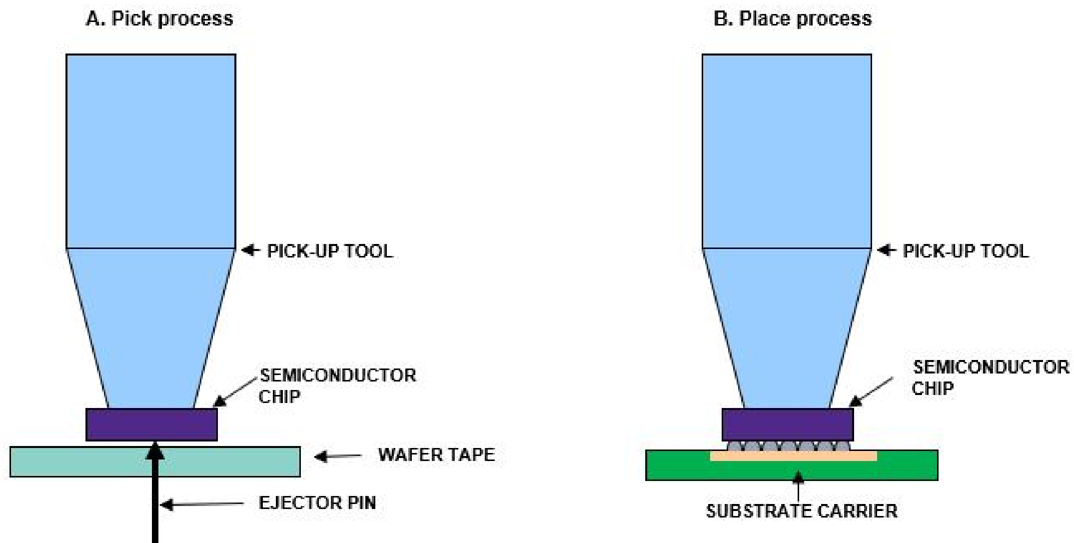

Fig. 4. Actual pick and place process

of the chip resulting to thrown RF dies during pick and place process by adding a blower or ionizer in the machine as illustrated in Fig. 5. With this improvement, no thrown dies occur after implementing the blower ionizer. One of the advantages of the solution is the unit per hour (UPH) is increased because this will skip the 100 % visual inspection on the actual unit to meet the cycle time faster and this is a good achievement to make the delivery of units will move firm as well. This can also have a good reliability results when the package is subjected to 1000 hours thermal cycling. A medium to large scale of validation was done to see the difference on the improvement done.

Fig. 6 shows the trend chart of thrown dies from January to May with a series of three different machines. Machine 1 has a 79 percent improvement from January to May, machine 2 has an 84 percent and machine 3 comes with a 76 percent improvement. With this trend of 3 different machines, an average of 80 percent improvement in total was achieved by implementing the solution of blower ionizer in pick and place process. Note that the actual number are not intentionally shown due to confidentiality.

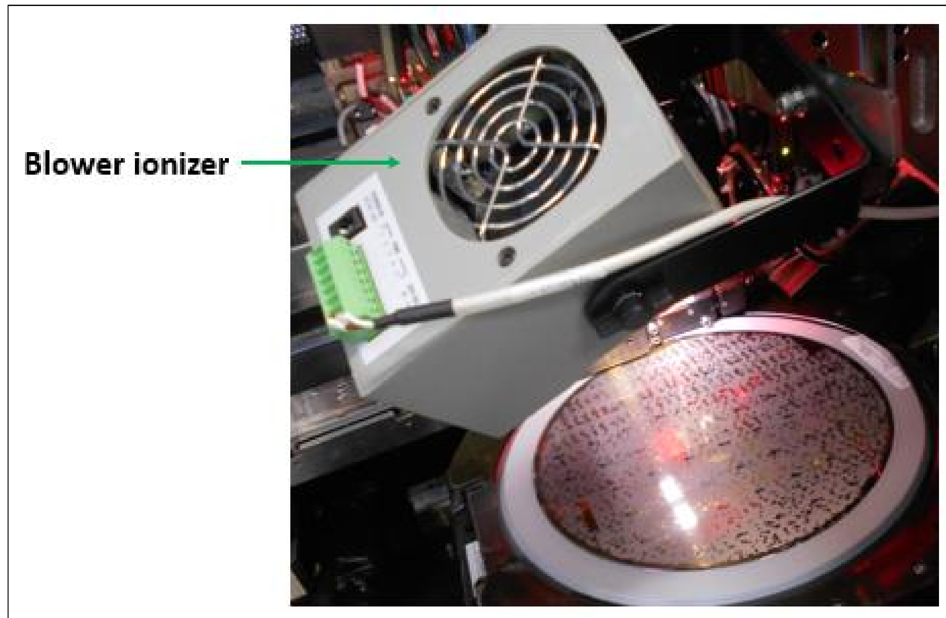

Fig. 5. Actual photo of blower ionizer on the machine

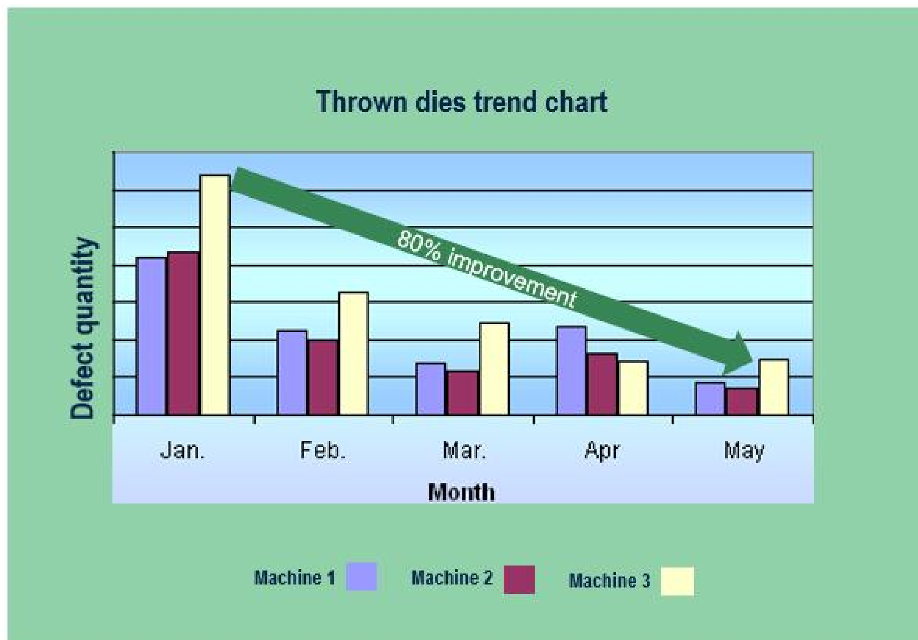

Fig. 6. Thrown dies trend chart

4. CONCLUSION AND RECOMMENDATIONS

The paper discussed a process solution and improvement in addressing the thrown RF dies issue or dies fly-off defect at pick and place assembly process. By adding a blower ionizer near the picking of RF IC chips, thrown dies occurrence was successfully mitigated with around 80 percent reduction. The improved solution is considered a key milestone which could be used for future reference in all semiconductor industry without blower ionizer inside the machine.

For succeeding works and studies, comparison of existing works should also be included for added analysis. Studies and learnings shared in [11-14] are helpful to improve the assembly processes particularly the diebonding process. It is highly recommended, if not necessary, that the assembly manufacturing processes observe proper ESD controls. Opportunities highlighted in [15-16] are useful to help ensure ESD check and controls. Eventually, continuous improvement is important for sustaining the quality excellence of any product and of the assembly manufacturing plant.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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