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Innovative Solution to Eliminate Sn Flakes Migration at Package Singulation on a QFN Sn Plated Stepped Cut Design

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Keywords— *Sn Flakes, QFN SN Plated, Package Singulation, Stepped Cut Design.*

I. OVERVIEW

- Package Singulation partial cut process of a Quad Flat No Leads (QFN) Package is now well-known at semiconductor manufacturing to enhance the Automatic Optical Inspection (AOI) capability of a finished Integrated Circuit (IC) device when subjected into surface mount on its respective functionality board.
- To obtain device units with step cut side wall profile, a QFN package strip must underwent on two (2) package sawing processes; Partial cut -sawing and Full cut sawing process.
- Partial cut sawing of a QFN package strip aimed to perform target cut depth on the Lead frame (LF) only that defend on the customer requirements prior the full cut sawing.
- After completing the package Partial cut sawing, the package will now able to undergo on a Tin plating process to coat the LF exposed copper material on a QFN package strip prior the full sawing process.
- During Package Full sawing process, an optimized combination of blade rotations and feed speed contribute good sawing quality to separate package units on the package strip.
- Figure 1.0 below illustrate the End of Line (EOL) process flow specifically for package singulation.

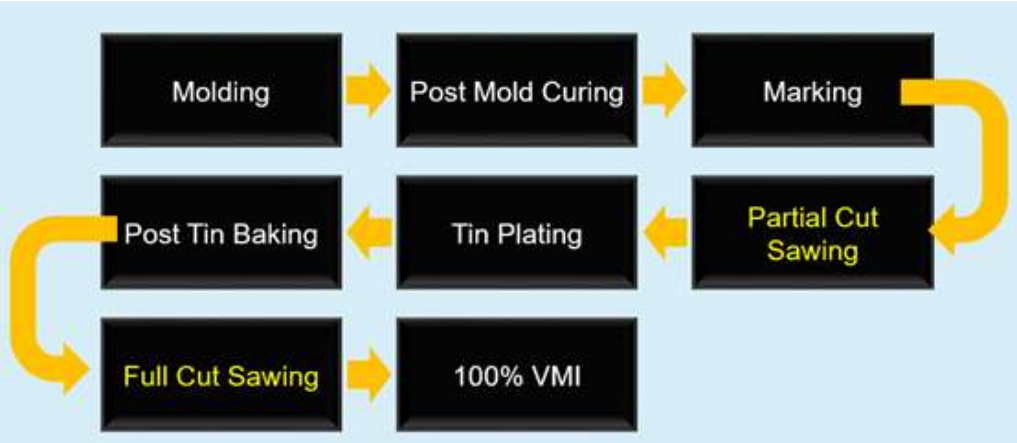

Figure 1.0 Process flow of a typical QFN package with Step cut sawing

II. PROBLEM IDENTIFICATION

- After Full sawing process, step cut profile must be measure to validate good sawing quality. 100% visual and mechanical inspection also useful to screen out the whole production lots to prevent scape defects such as mis-align cut, off set cut, units side wall chipping, lead burrs and leads smearing (standard QFN inspections). New defects found out which is leads shorted to adjacent leads contributed by Sn (Tin) flakes migration during Full package sawing process.
- Migrated Sn flakes has been detected during the 100% VMI. It has been observed located at step cut area near the conductor leads terminal as per figure 2.0 below.
- Applied Sn surface on sawing street of a half cut package strip migrated towards terminal leads during package full sawing process due to contact force from highly rotating blade. Sn migration moves towards the open space area which is the top surface of package strip wherein the direction of Sn flakes is directly the same as the direction of blade and feed sawing direction.as per Figure 3.0 below illustrated.

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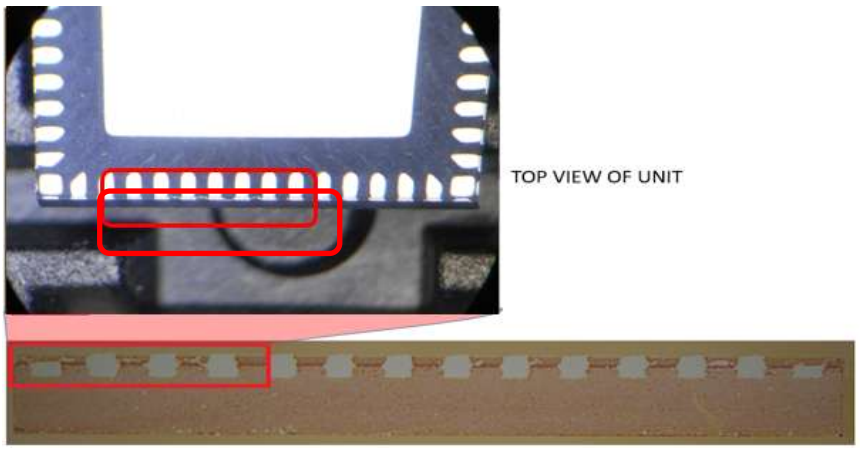

Figure 2.0 Sn Flakes located at Terminal leads (top and side view)

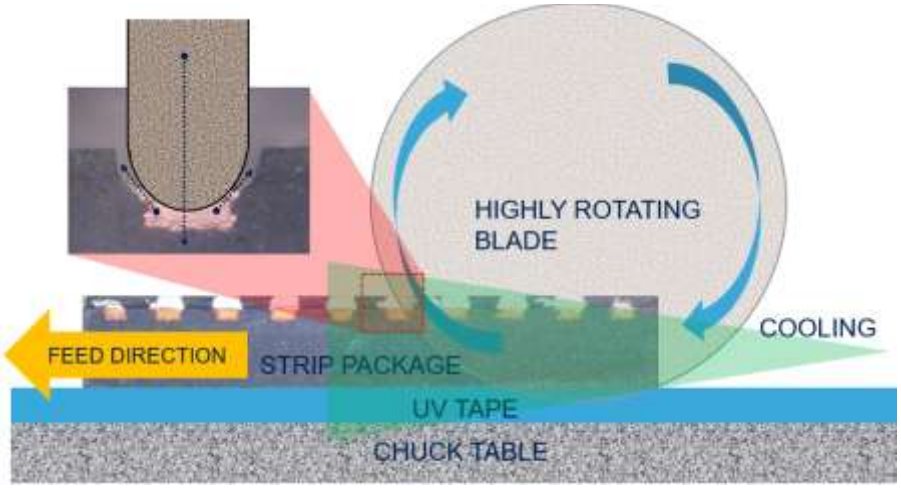

Figure 3.0 Sn Flakes migration during package full sawing process.

- On above Figure 3.0, Migration of Sn flakes during Package Full sawing was a reaction from the force executed by the highly rotating blade. The factors of Sn Material reaction are directly proportional to the Angular forces and temperature generated by blade during the sawing process. As we can see the blade rotated in a clockwise direction with a conventional work piece feed sawing direction. On this scenario, the Sn flakes reacts as malleable material due to heat generated between package and blade that has been transferred on Sn coated area located at saw street. Sn flakes has been made as below figure 4.0 illustrated.

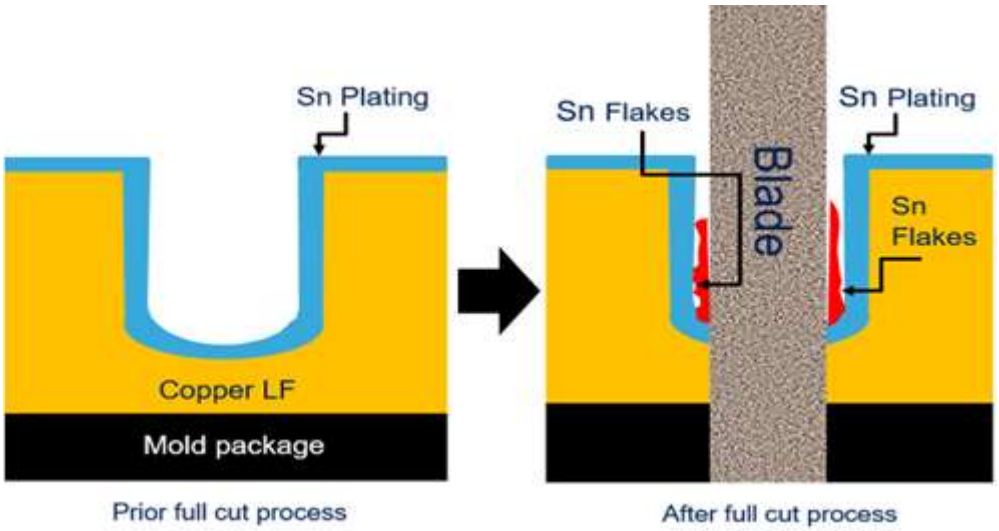

Figure 4.0 Sn flakes generated during Sawing induced by heat transfer.

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III. DESIGN SOLUTION

- In order to eliminate Sn flakes generated during Full Package sawing, we need to consider the cooling system on the dicer module to prevent heat transfer between highly rotating blade and Sn coated metal connecting bar. A conventional cutting water nozzle and spray bars supplied by chilled deionized water are commonly used by the manufacturing. Figure 5.0 below is the design to improve the cooling system of the dicer for the QFN full Package sawing. Below figure 5.0 have a much better cooling capability even for the thicker packages to accommodate even with special requirements like partial package sawing.

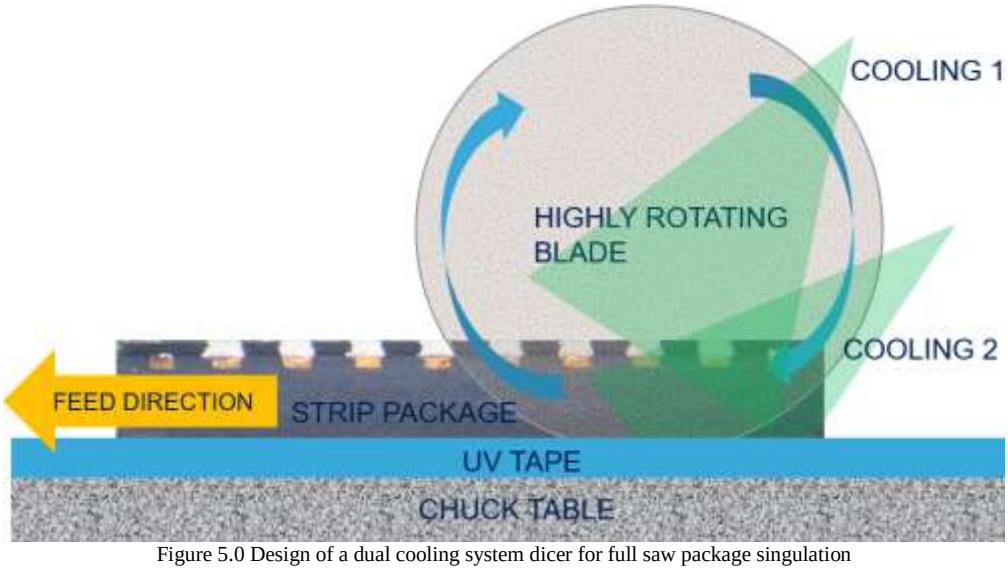

Figure 5.0 Design of a dual cooling system dicer for full saw package singulation

- Two (2) cooling system has been installed to regulate heat transfer between highly rotated blade and metal surfaces. The cooling no.1 aimed to act as coolant on blade assembly and top surface of the work piece package while the cooling no. 2 aimed to act as a coolant between the contact of blade and the work piece package.
- On this cooling system set-up, temperature generated between work piece package and highly rotated blade will be regulated. Heat transfer will be eliminated as well the generation of Sn flakes during sawing process would be addressed.

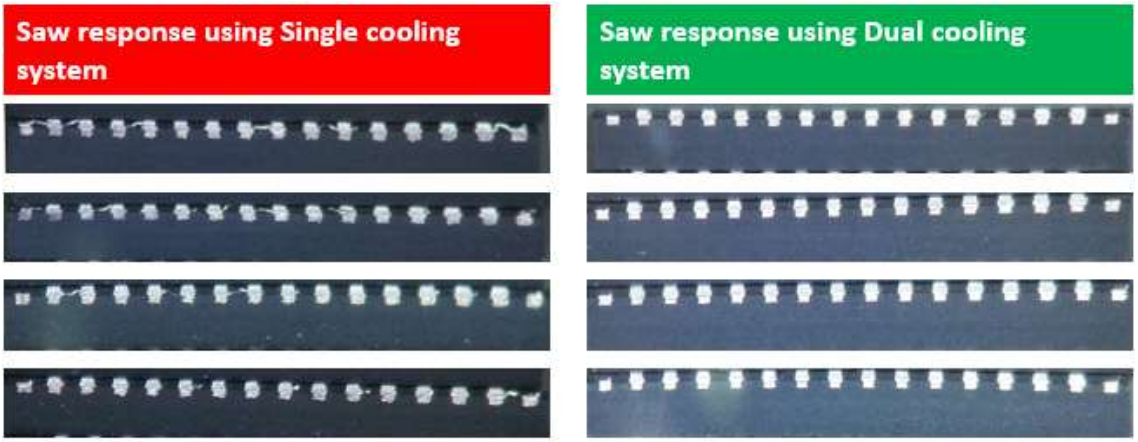

Figure 6.0 Design of a dual cooling system dicer for full saw package singulation

- Above Figure 6.0 shows a comparison of units underwent different dicer cooling system. Presence of Sn Flakes that shorting two leads terminal will be seen on single cooling system (only cooling 1 used) versus a dicer that using a dual cooling system (with cooling 1 and cooling 2).
- Introduction of Dual cooling system for Package singulation partial cut and full cut process as corrective action for Sn Flakes migration resulting to a lead to lead shorting has been successfully eliminated during the course of this study.

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