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Package Chipping Elimination through Indented Sidewall Integration

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Abstract— *The paper presents an alternative semiconductor package design for quad flat no-lead (QFN) devices to eliminate the occurrence of topside chipping rejection during mechanical singulation. The discussion includes a unique design of mold chase for plastic encapsulation process of a semiconductor device and a specialized singulation mechanical cutting technique. Moreover, authors' insights are shared to realize the manufacturability of the augmented design and process during assembly especially on the critical process steps of "molding" and "singulation".*

Keywords— *Quad flat no-lead; mold chase design; package chipping elimination; design improvement.*

I. Introduction

A quad flat no-lead (QFN) device is one of the several packaging techniques under surface mount technology (SMT) wherein the silicon die is mounted on leadframe pad through electrically conductive glue. The advantage of this architecture from other form of integrated circuit (IC) designs is its good thermal performance due to exposed thermal pads and lower package stand-off, reduced lead inductance, smaller package dimension and thin profile.

QFN device is made from series of assembly processes of front-of-line and end-of-line stations starting from die preparation to package singulation and packaging. During this individual process steps, the defect and rejection is closely monitored to produce a robust device but there are instances of defect escapee that could be detrimental to end-user applications.

Mold crack is one of the major rejects from singulation process originating from large topside and sidewall package chippings of the plastic encapsulant. Chippings shown in Fig. 1 is the result of abrasion from the mechanical blade of singulation process during cutting or separation of units. Multiple known approaches to minimize the topside chippings in Fig. 2 are available such as parameter optimization, blade evaluation and selection, and leadframe design resolution, however such actions cannot completely eliminate the occurrence of the defect.

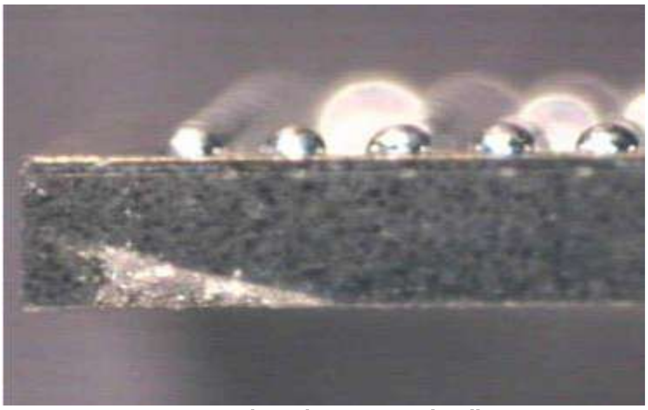

Fig. 1. Package chippings on sidewall.

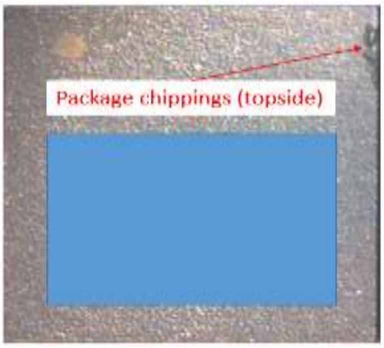

Fig. 2. Package chippings on topside.

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In the succeeding section of this paper discusses a proposal for QFN architecture to eliminate the topside chippings. The method for assembly is also presented and the insights from the authors to realize the manufacturability of this novel design.

II. Design and Process Solution

Conventional QFN design in Fig. 3 is composed of silicon die bonded to a leadframe pad with the bondpads connected to the leads through the wires. The overall unit is encapsulated by a molding compound material covering the internal active circuitry. The standard singulation process for this design is the mechanical sawing, producing straight outline and abrasion mark on the sidewall section.

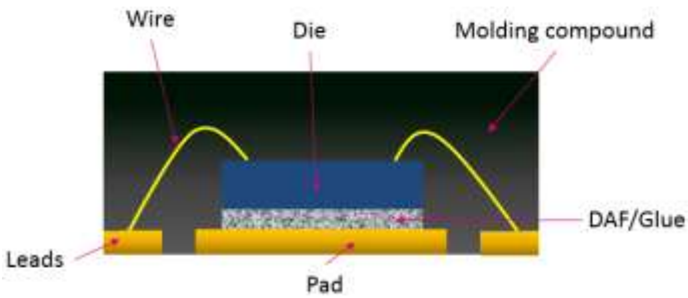

Fig. 3. Standard QFN cross-sectional view.

An enhanced design is shown in Fig. 4 with its cross-sectional view. The indented sidewall is the modification and integration on the design to reduce the contact of mechanical blade during cutting. With the design improvement, chippings done by abrasion can be significantly minimized.

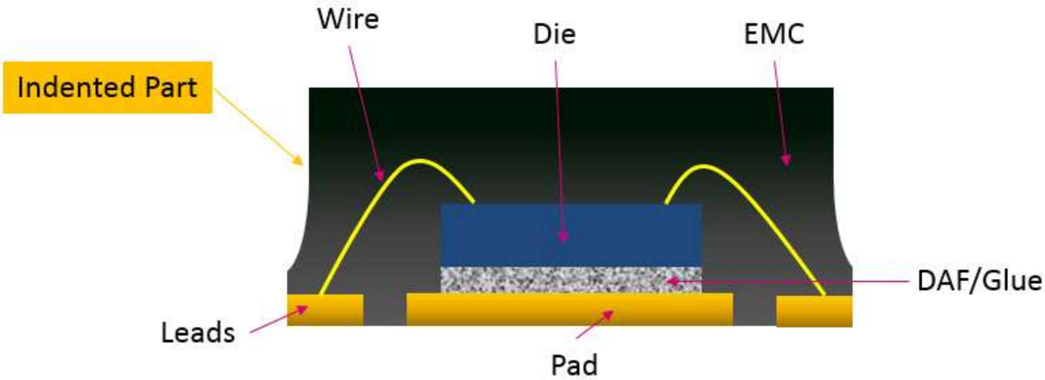

Fig. 4. Enhanced QFN design.

A specialized molding process and the recommended mold chase design is illustrated in Fig. 5. The size and dimension of the "grid" design for mold chase is dependent on the package size requirement of the QFN device.

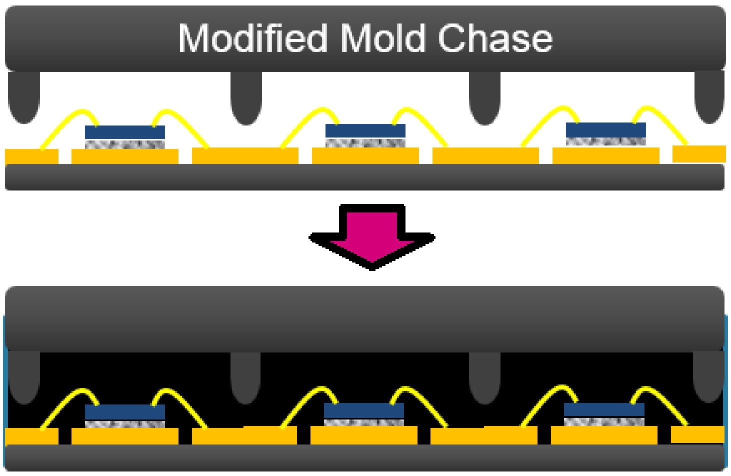

Fig. 5. Advanced design of mold chase.

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The required cutting method for the enhanced design is shown in Fig. 6 wherein the distance of the mechanical and indented sidewall depends on the singulation cutting capability. The width of the mechanical blade should also be considered on the distance of device pitching.

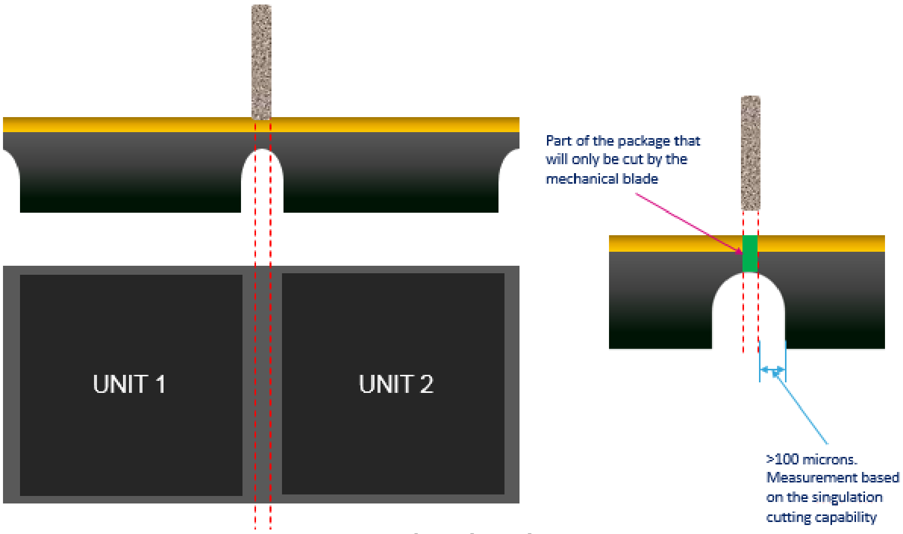

Fig. 6. Mechanical singulation.

Wirebonding diagram and process optimization should be considered carefully, with wires maintaining acceptable distance between the indented sideall and the wire as depicted in Fig. 7.

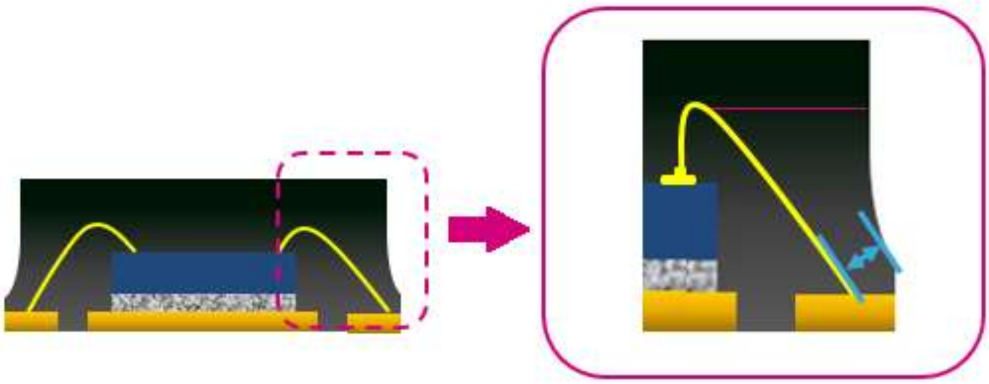

Fig. 7. Wiring illustration.

The advantage of this proposal as compared to existing QFN design benefits the elimination or reduction of package chippings which could impact the quality of QFN devices. Manufacturability as well gain positive impact since the proposal has cost reduction iniative such as blade life extension. In addition, mold delamination or crack is also avoided by the application of this proposal.

III. CONCLUSION

Providing the innovative design of QFN eliminates the occurrence of package chippings together with related defect such as mold delamination. The enhanced design impacts the manufacturability through cost redution initiative due to the potential blade life extension.

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