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Mechanical Singulation-free High-density Matrix Semiconductor Package

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***Abstract*— *High density matrix semiconductor package is assembled by attaching a die on a carrier using a die attach material, electrically connecting the die to the carrier using a wire, encapsulating the package using an encapsulant, laser dicing the encapsulant layer on one side, and back-etching the frame on the other side to isolate the leads, the pad and the unit. The unit-to-unit distance is limited by the size of the laser beam (50-100 µm) thereby providing more footprint to build high unit density in the matrix frame as compared with conventional mechanical blade singulation where unit-to-unit distance requirement is 300-350 µm.*

***Keywords*— *Laser dicing, etching, matrix frame, singulation.*

I. Introduction

Increasing the density of units in a matrix frame in the assembly of semiconductor packages will significantly increase profit margin. Cost reduction efforts constantly drive innovative solutions to existing materials and process flow. In the case of conventional blade saw package singulation in the standard quad flat no leads (QFNs) package assembly, a specific saw lane width (300 - 350 µm) is required. Reduction of the saw lane width would increase the density of units in the strip (Fig. 1).

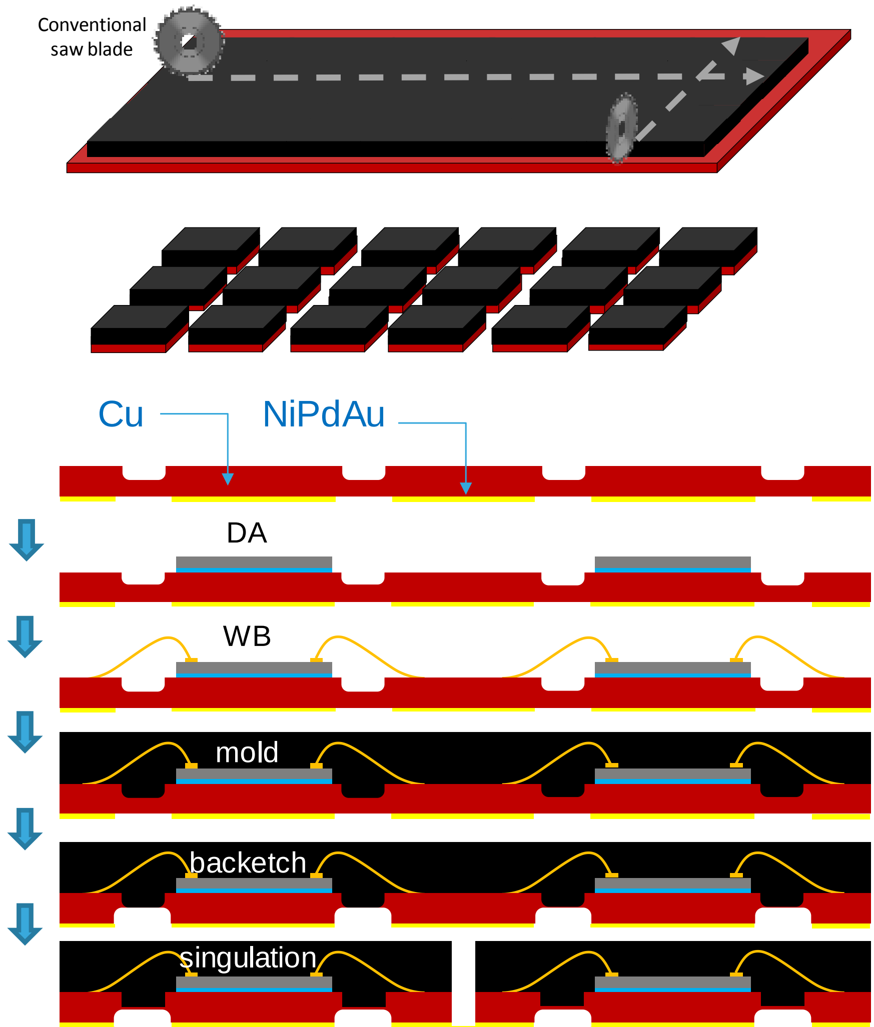

Fig. 1. Schematic of conventional mechanical blade singulation, and the package assembly flow. DA – die attach; WB – wiebond.

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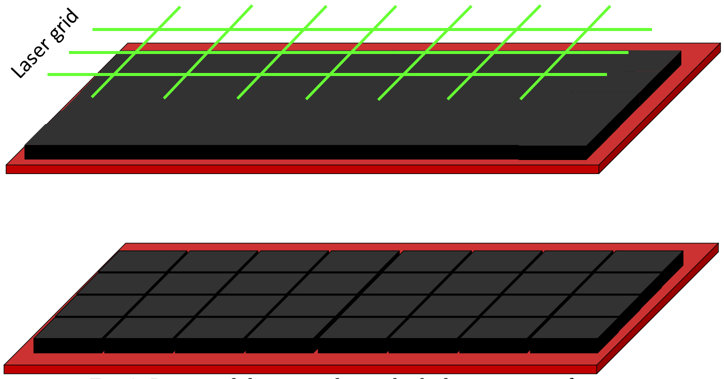

Fig. 2. Laser grid dicing producing high-density matrix frame.

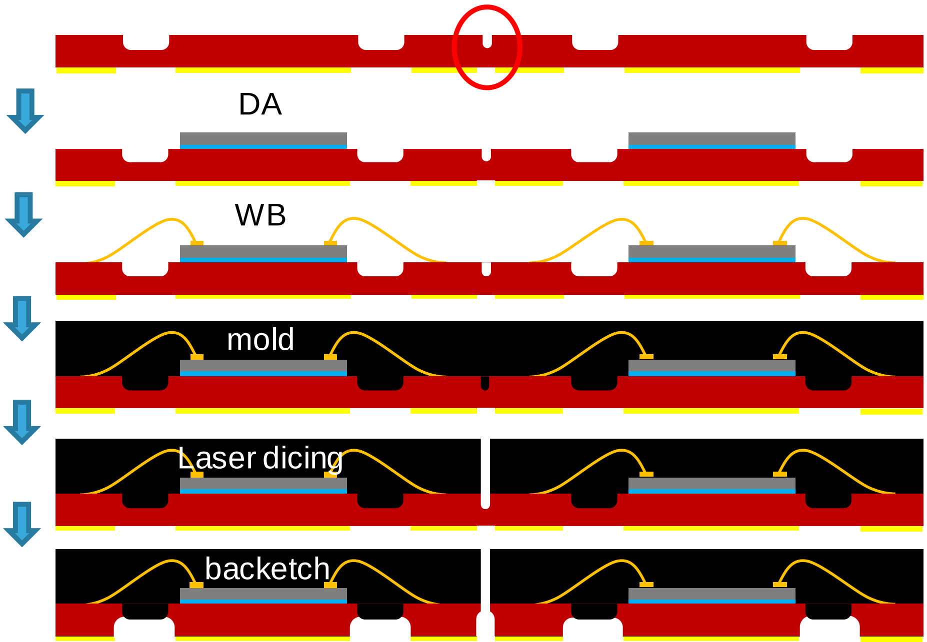

Fig. 3. Package assembly flow using a notched frame. DA – die attach; WB – wiebond.

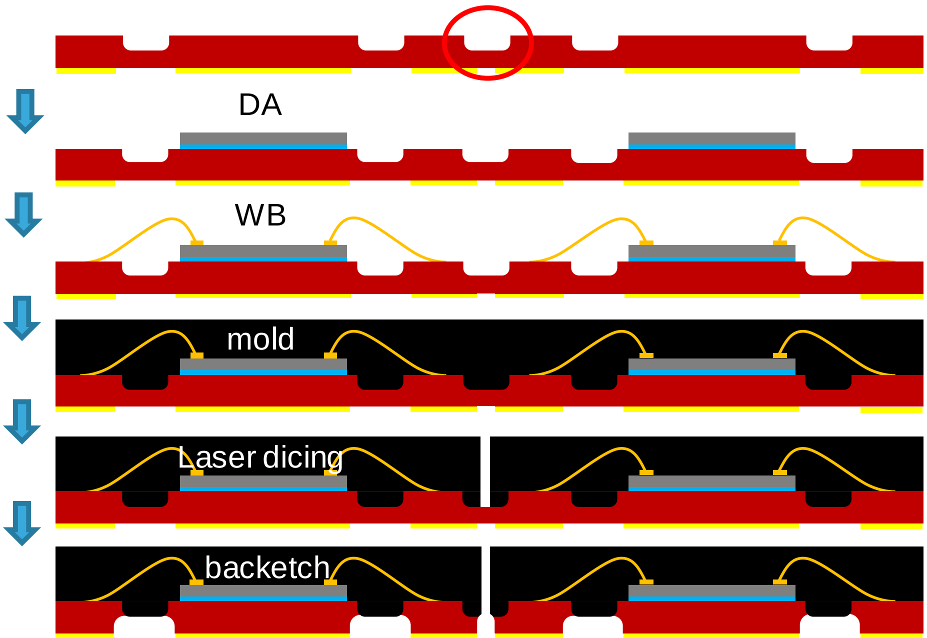

Fig. 4. Package assembly flow using a half-etched frame. DA – die attach; WB – wiebond.

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One strategy to reduce the saw lane width is the use of a thinner blade. However, thinner blades are prone to wobbling and blade crack, chip out and inconsistent cut depth, resulting in lower assembly yield and increase in production cost.

II. Design and Process solution

The solution assembles semiconductor packages by attaching a die on a carrier using a die attach material, electrically connecting the die to the carrier using a wire, encapsulating the package using an encapsulant, laser dicing the encapsulant layer on one side, and back-etching the frame on the other side to isolate the leads, the pad and the unit. The new package uses a new leadframe design to include a groove/notch (Fig. 3) or a half-etched portion (Fig. 4). The laser grid dicing cuts the epoxy molding compound (EMC) based on the package outline requirements. The back-etching process, a chemical treatment to dissolve the exposed copper portion of the frame (not masked by the NiPdAu plating layer) creates the lead-to-lead, lead-to-pad and unit-to-unit isolation.

The primary advantage of laser grid dicing is that the laser width (50 - 100 μm) is narrower than the saw lane width (300 - 350 μm) which means that the unit density in the matrix frame can be significantly increased. In addition, there is generally a reduced mechanical stress on the package induced by the mechanical blade dicing process. Laser grid dicing is expected to have a higher UPH than conventional blade saw dicing because of the simultaneous cut based on the grid pattern. Moreover, simultaneous lead-to-lead, lead-to-pad and unit-to-unit isolation process during the back-etching process can be achieved.

III. Conclusion

The solution enables high-density matrix semiconductor package by utilizing laser grid dicing which cuts the EMC based on the package outline requirement, and back-etching process to simultaneously achieve lead-to-lead, lead-to-pad and unit-to-unit isolation. A notched or half-etched frame enables the process solution.

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