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Enhancement of Multiple Fiducial Reference for Strip Warpage to Prevent Mis-align Cut at Package Singulation

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I. OVERVIEW

- Package sawing process in semiconductor assembly manufacturing is a process typically performed to separate integrated circuit packages such as IC chips from a substrate / leadframe in order to form the individual units.
- Two (2) types of package singulation already available in the manufacturing industry today. Jig sawing which uses rubber jig plus vacuum and Tape sawing process which uses UV tape.
- Different materials such as Lead frame base package and substrates base package modules are prone to warpage which induced by residual stresses during moulding process and by subjecting to different temperature afterwards.
- Complicated packages today such as partial package sawing of products must require high tolerances of kerf-width to protect from any possible mis-align cut defect that will be encountered during partial package and full package sawing process.

II. PROBLEM IDENTIFICATION

- Due to warpage inherency on all moulded packages such as Ball Grid Array (BGA), Land Grid Array (LGA) and Quad Flat no Leads (QFN) modules, variation of Fiducial References at Y-position are being encountered which leads to theta shift resulting to mis-align cut defect.
- Figure 1.0 shows different type of warpage and how they affect the sawing integrity in terms of fiducial alignment references.
- It is illustrated that a high risk of mis-alignment cut falls on the red arrow cutting line while it is considered low risk (green arrow) cutting lines with regards on warpage type level.
- Figure 2.0 shows mis-aligned cut during full cut singulation resulting to a shorted leads or copper smearing on side wall wherein partial cut is not visible.

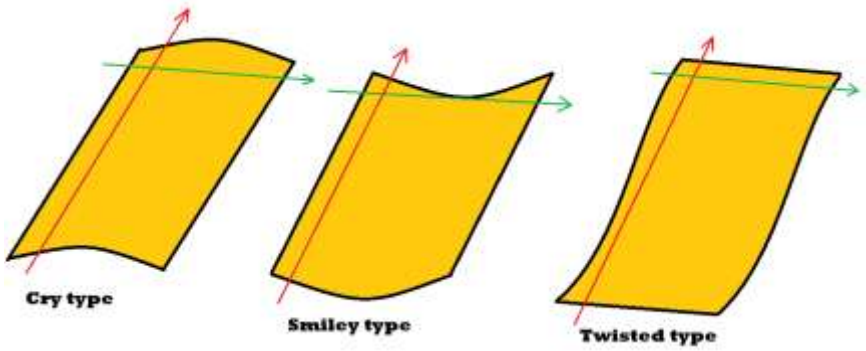

Fig. 1.0 Different warpage level with saw line integrity.

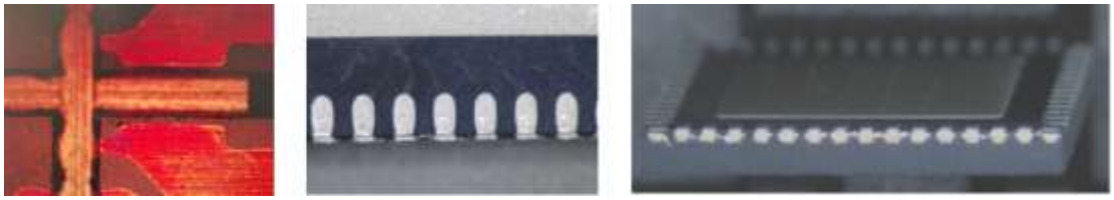

Fig. 2.0 Actual failure mechanism (mis-aligned cut)

- The occurrence of mis-aligned cut on Figure 2.0 has two factors; One is the mis-aligned cut during partial package sawing process and mis-aligned cut during Full package sawing process. Mainly the root cause of mis-alignment is the theta

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movement contributed by variation of Y-axis positions of reference fiducial. Figure 3.0 below illustrated the warpage contribution that disturb the cut alignment using least square theta limit.

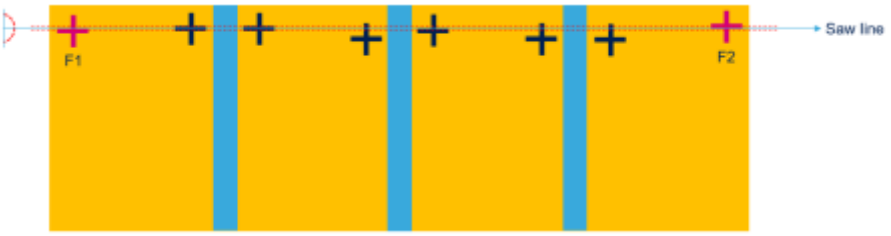

Fig. 3.0 2 points Fiducial alignment reference

III. DESIGN SOLUTION

- In order to achieve a passing requirement in terms of accurate alignment, we need to compensate the warpage type level condition of Materials by defining good Fiducial alignment references.
- Considering the number of reference fiducial matrixes per panel, mis-aligned cut could be eliminated by using multiple fiducial reference per panel. Figure 4.0 shows result of tight Fiducial Y-axis positional variation acceptance with saw line unlike the standard 2 points end-to end fiducial design used by standard QFN, LGA and BGA today as shown in Figure 3.0.

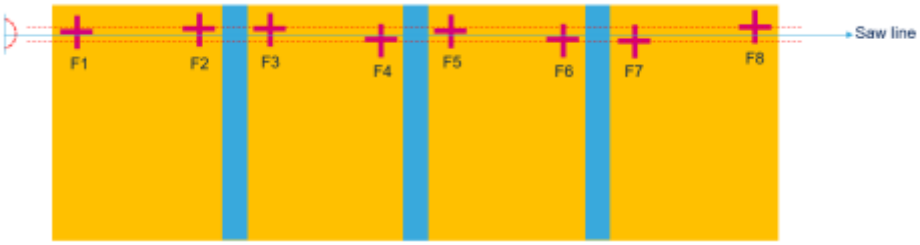

Fig. 4.0 Multiple Fiducial alignment reference.

- By applying multiple fiducial reference alignment, theta shifting will be controlled on the Y-axis positions centering the target saw street that will offer a precise cutting alignment resolving mis align cut.

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