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Factors and Effects of Blade Geometrical Distortion on QFN Package Partial Cut Sawing Process

Alvin S. Soreda, Ernesto T. Antilano Jr.
New Product Development and Introduction, Back-End Manufacturing & Technology,
STMicroelectronics, Inc., 9 Mountain Drive, LISP II, Calamba 4027 Laguna, Philippines

Keywords— *Blade Geometrical distortion, kerf width, Partial cut sawing process.*

I. OVERVIEW

- Quad Flat No leads (QFN) Packages used copper base lead frame that was commonly known as a ductile material which has challenging methods on package sawing process such as pre-cut sawing for Automotive products on manufacturing today.
- Blade constructional configuration includes inner diameter (ID), outer diameter (OD) and thickness geometry usually rectangular for kerf width requirements.
- Blade mechanical composition consist of diamond grits (abrasive grains), bonding materials (to hold the abrasive grains) and bonding type concentration (volume of abrasive grains) which are all depends on manufacturing requirements.
- A combination of optimized Blade revolution rate and optimized workpiece load feeding speed has been required for an optimum sawing parameters to obtain good cutting quality on a Copper base packages such as QFN devices.
- On Package sawing process, Blade geometrical distortion has a big impact with regards on blade cutting profile that are necessarily important for partial cutting processes such as partial cut.
- Partial cut process requires step cutting as figure 1.0 illustrated. Cut width and cut depth is very critical since two types of blade thickness has been used to obtain precise partial cut profile (side wall) for singulated units after full cutting process.
- Blade 1 is the sensitive process to obtain good solderable side wall profile. Blade 1 rectangularity profile needs to be maintain to obtain good partial cut depth requirements on both sides of a singulated units.
- Blade 2 requires thicker size versus the Blade 1 in order to have a partial cut profile. The criticality of Blade 2 is the centering position from Blade 1 to obtain good partial cut result.

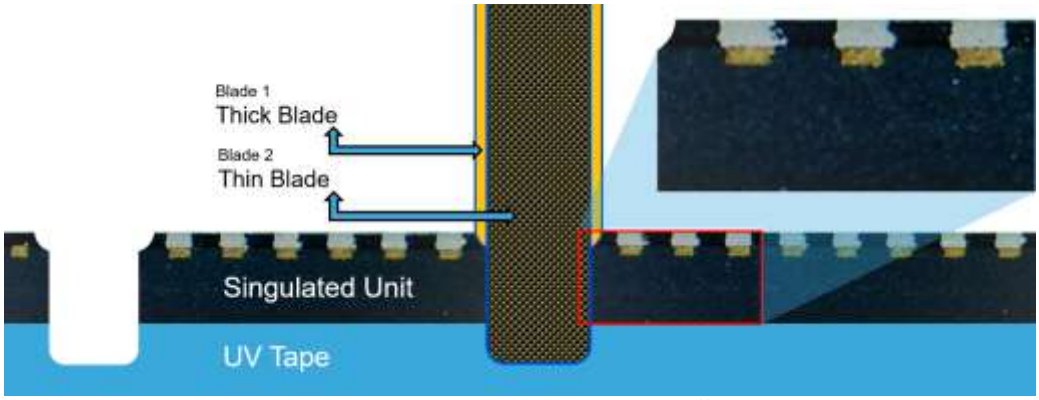

Fig. 1.0 Typical Partial cut package sawing process using two different blade thickness.

II. PROBLEM IDENTIFICATION

- With the combination of feed speed and Blade revolution, blade induced loading pressure on work piece (specially on QFN packages) resulting mechanical stress on blade structures as commonly known as blade wearing out.
- Wearing out of blade during package sawing is normal due to loading contacts of blade abrasive diamonds grains on work piece package contributes mechanical shearing force in order to perform cutting process.
- Eventually, As Figure 2.0 illustrated that warpage of strip package contributes uneven shearing distribution on blade geometrical figure resulting to alter the blade tip from rectangular shape into irregular shape that contributes no good side wall on a singulated units.

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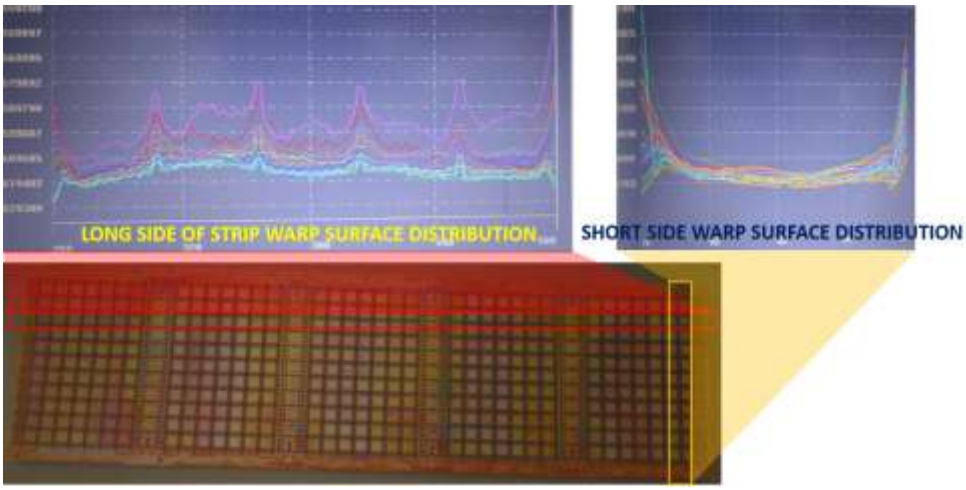

Fig. 2.0 Graphical surface distortion of a warp QFN package strip.

- The graph represents the surface of a package located at the long side and short side of the strip. Spikes lines on graph shows that the strip is affected by surface distortion and curved lines represents the warpage level of a QFN package strip. On this case there are two variation of planarity distortion; the irregularity of flatness and bending of railings (remnants or non-active areas). The yellow circle shows the area affected by bending and the red arrow shows the area affected by warpage.

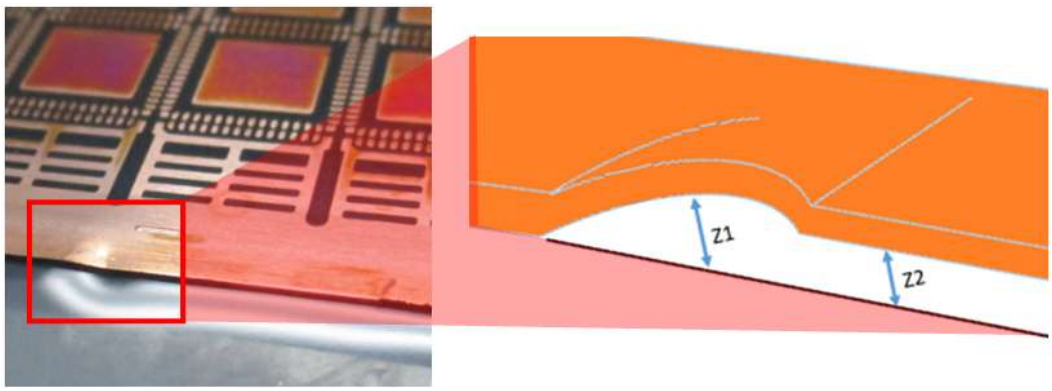

Fig. 3.0 Bended railings located at side area of strip package.

- Figure 4.0 and Figure 4.1 illustrate how the blade tip geometrical figure becomes distorted during cutting when subjected on the QFN warp strip package. The blade cutting profile with regards on singulated units side wall becomes distorted whereas it affects the Partial cut depth profile even maintaining the blade depth position from package surface during sawing.

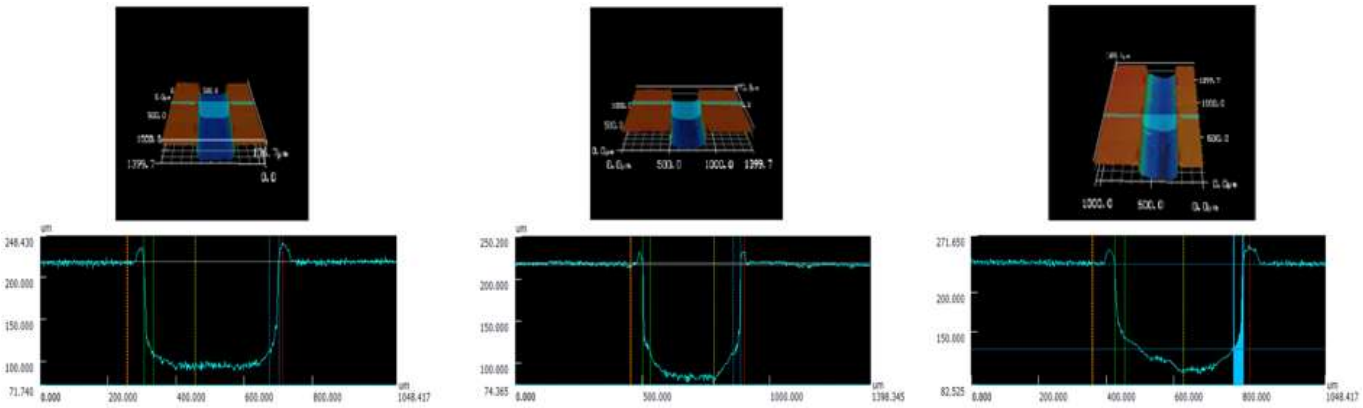

Fig. 4.0 Different cutting profile after Pre-cut (using Blade 1).

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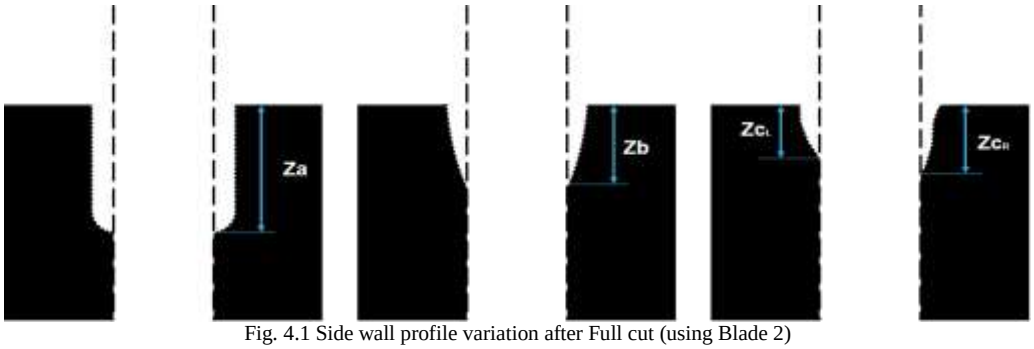

Fig. 4.1 Side wall profile variation after Full cut (using Blade 2)

- Fig. 4.1 also illustrate the blade geometrical structure affecting the side wall cut depth profile of singulated units. Shallow cut depth has been encountered at unit number three (3) with Zc partial cut due to irregular blade geometry contributed by distorted surface of package affected by bended railings and warpage of strip package.

III. Design Solution

- In order to obtain side wall structure on Figure 5.0, cut depth requirements needs to be maintain. Two (2) area of actions needs to be consider;
    1. Use thicker Blade size for Blade 1 in order to compensate geometrical effects of blade distortion as per figure 5.0 illustrated below.

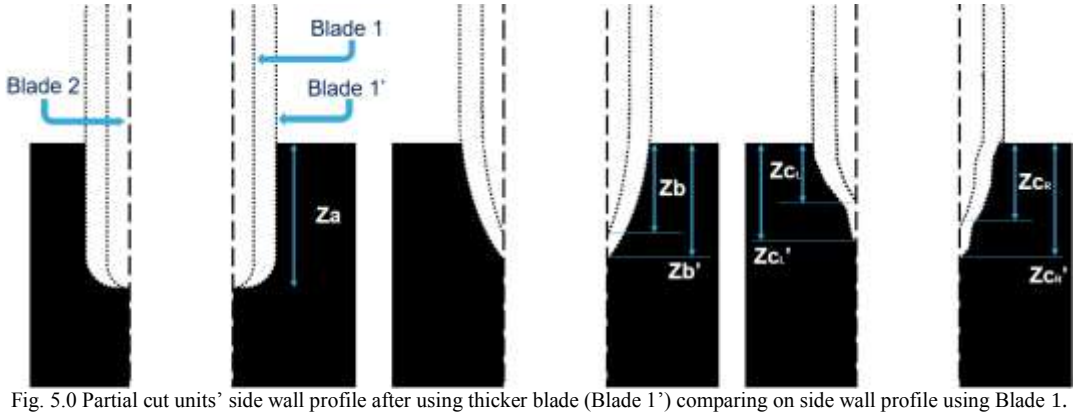

Fig. 5.0 Partial cut units' side wall profile after using thicker blade (Blade 1') comparing on side wall profile using Blade 1.

    2. Increase the depth cut height position of Blade 1 in order to compensate the geometrical effect of blade distortion as per figure 6.0 illustrated.

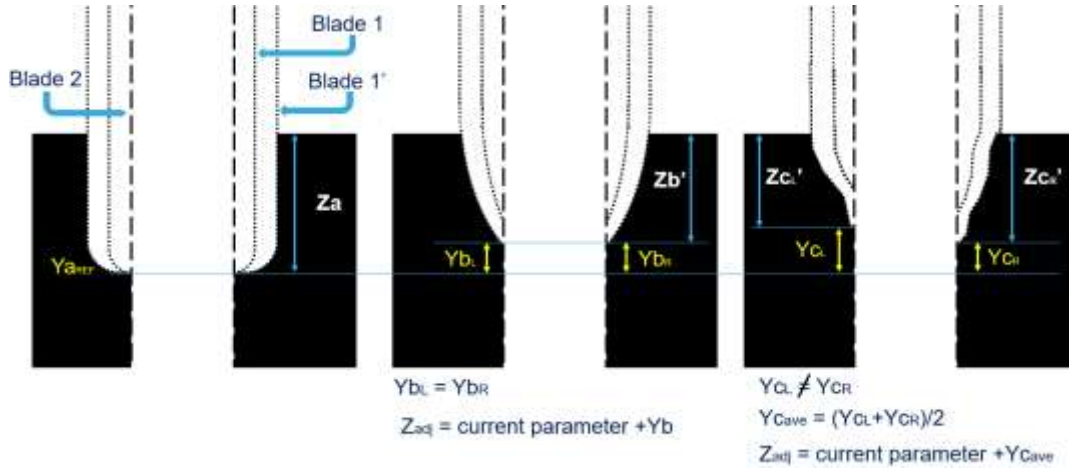

Fig. 6.0 Cut depth adjustments computation formula.

- To achieve a perfect blade geometry on a partial package sawing with its stringent requirement on cut depth, blade structure and composition must be considered and its compatibility to material that are being used.

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