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Proactive Verification of Strip Y-Index to Mitigate Gross Misaligned Cut due to Mismatched Unit Pitching

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Authors' contributions

This work was carried out in collaboration among the authors. All authors read, reviewed and approved the final manuscript.

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ABSTRACT

Shopfloor practices that when the first cut line was aligned with the hairline, actual blade cut, and saw street of the strip, the succeeding cut lines will automatically follow with the same alignment. Considering various factors that affect the condition of the strip, it was recommended to verify the succeeding cut lines of the strip to project if the hairline will still be aligned with the saw street as cutting goes on. Unfortunately, verification of succeeding cut lines was usually skipped and refer only with the first cut alignment as reference. Thus, end up risking the units for possible cutting misalignment. Cutting misalignment can be encountered when the programmed unit pitching measurement was mismatched with the actual unit pitch of the strip. However, mismatching of the unit pitch can be anticipated through y-indexing where the saw street of the strip will be verified for alignment with the hairline along the succeeding cut lines. Frequent occurrence of mismatched unit pitching was brought about by the strip condition after series of assembly processes that expands and retracts the strip. With the mentioned scenario which has been encountered from different semiconductor assembly plants, it was best to verify the y-indexing of the strip on top of verification on the first cut line alignment. Application of y-indexing verification is essential for the entrapment and correction of mismatched unit pitching. Rejection of units due to misaligned cuts can also be prevented. Assistance of operators to adjust and monitor the hairline to compensate the actual pitching was also avoided as early as first cut line verification.

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Keywords: Alignment; singulation process; sub-index checking; unit pitch; Y-index.

1. INTRODUCTION

Singulation process efficiency relates to the correct dimensions of the individual units produced after sawing. In order to produce good units, alignment of blade cut to every saw street of the strip was important. Upon processing of a strip for singulation, the first saw street between the strip remnants and first row of good units will be cut. This first blade cut will be shown by the machine for verification of actual blade cut to the saw street of the strip and guided with the machine hairline. Hairline of the machine indicates where the blade will saw through. Personnel can adjust and correct the alignment if otherwise. Fig. 1 shows the hairline that was aligned with the actual blade cut.

Fig. 2 shows the first cut line alignment on the machine that was not needed for adjustments. The hairline of the machine was aligned with the saw street of the strip. On the other hand, Fig. 3 illustrates cut line alignment that needs to be adjusted as the hairline was not aligned with the saw street of the strip. Misaligned hairline with the saw street results to misaligned cut units when skipped without adjustments made. Hairline is the guide where the blade saw through while saw street of the strip is the actual separation of the individual units.

However, few strips that was verified to be aligned upon the first cut line, still encounters gross misaligned cut that was quantified and rejected after sawing. This was due to mismatch of actual unit pitch to the programmed unit pitching on the machine. The tendency was to have a compensation of unit pitching differences that will be developed to misalignment. Few strips need frequent assistance to align the cutting by adjusting the hairline of the machine and then closely monitor the cutting quality of the strips.

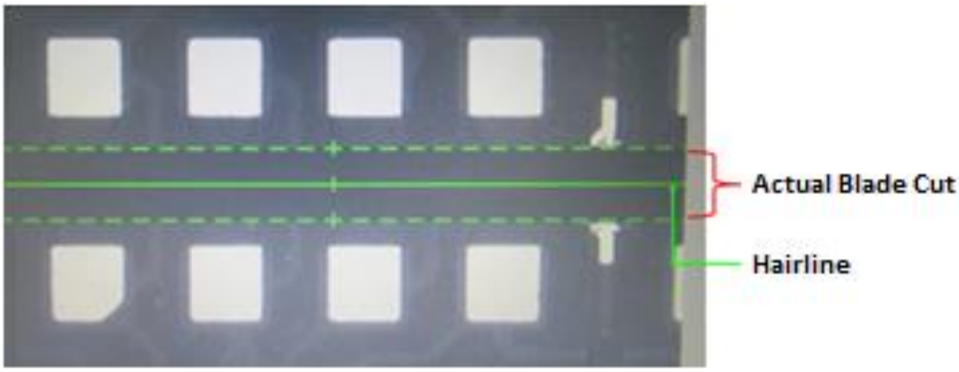

Fig. 1. Blade cut aligned with the hair line

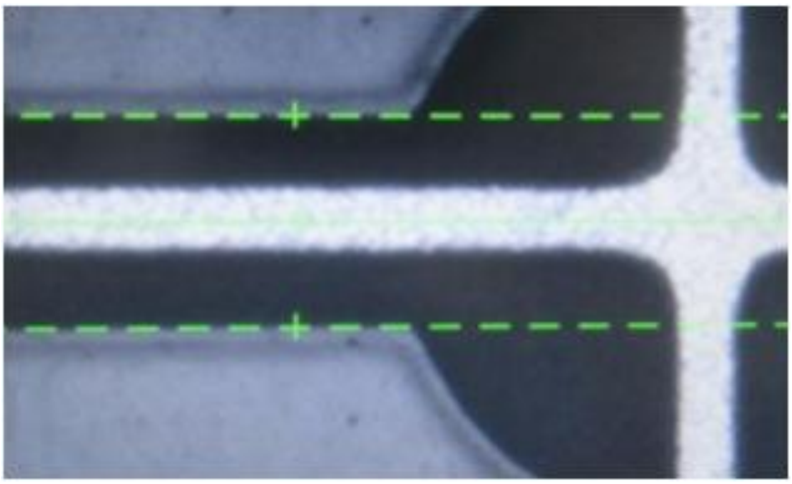

Fig. 2. Good alignment of hairline (green line) with the saw street

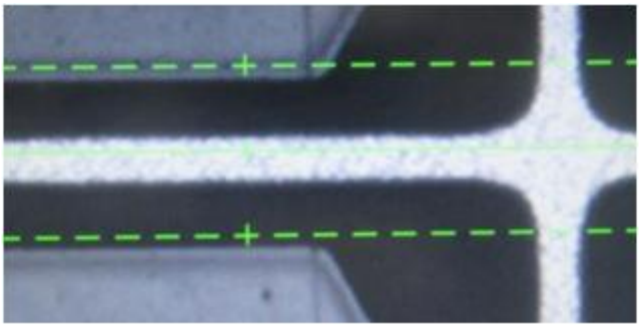

Fig. 3. Needs adjustment as hairline (green line) was offset with saw street

With the data on hand, the next step is to establish the best assistance that the shopfloor can perform upon encounter of mismatched unit pitching entrapped during vertical indexing (Y-indexing) verification on the strip under singulation.

Current practice on the shopfloor was to adjust and purposely offset the hairline alignment from the actual blade cut. The effect of adjustment will be applied on the next cut line. However, next cut lines might give off different alignments along the processing. Close monitoring was performed but the problem was still not resolved. The succeeding strips are expected to be assisted same with the previous strips, and another batch of lots will have different adjustment.

2. METHODOLOGY

The authors were engaged to find the best assistance that can be performed in the occurrence of strips affected with mismatched unit pitching. Brainstorming was done about the importance of sub-index checking known as the vertical indexing prior proceeding the lots for singulation, on top of the verification of first cut line alignment for horizontal indexing. Works and studies shared in [1-7] focused on the cutting method, design, and pattern recognition were helpful in this study. The authors have also studied about the existing assistance of shopfloor to adjust the hairline to catch up with the correct alignment. Program teaching was also explored for the efficiency to address the issue.

2.1 Understanding the Importance of Sub-Index Checking

In singulation process, sub-indexing refers to the movement and distance travels during scanning for alignment inspection. Two sub-indexes are being monitored which are the horizontal indexing (X-indexing) and vertical indexing (Y-indexing). X-indexing is where scanning inspection goes from left to right or vice versa. Y-indexing on the other hand, is where the scanning inspection goes from up to down or vice versa. Figs. 4 and 5 demonstrate the X-indexing and Y-indexing, respectively.

X-indexing was used to ensure that the cutting was aligned from the start and finish of the strip. Misalignment and slanted cuts can be verified by using the X-indexing along the strip. Y-indexing was used to verify the consistency and matching of actual unit pitching to the programmed unit pitching on the vertical movement. Through Y-indexing, it can be predicted if the succeeding cut lines have offset cut due to mismatched unit pitching brought about by the strip imperfections induced by the assembly process steps that the strips have undergone.

Fig. 4. X-indexing – horizontal travel movement

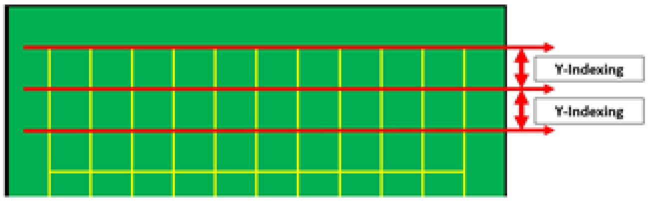

Fig. 5. Y-indexing – vertical travel movement

Through understanding of sub-index function and importance, it has been found out that Y-indexing can be used to predict the cutting alignment condition of succeeding cut lines. Mismatched unit pitching that might result to misaligned and offset cut can be expected and corrected as early as the first cut line verification.

2.2 How Hairline Adjustments Affects the Cutting Alignment

Semiconductor industries that process high dense strips have different activities to salvage the strips when mismatched unit pitching was encountered. Hairline follows the programmed unit pitch and does not automatically adjust with the actual unit pitch of the strip. One of the easiest assistance to avoid misaligned cutting of units was to purposely offset the hairline with the actual blade cut to adjust the cutting alignment. Adjustments made will take effect on the succeeding cut lines. This process was non-value added and critical to cutting quality. Thus, demanded to be closely monitored.

Fig. 6 illustrates the first cut line aligned with the machine hairline wherein the succeeding cut lines were aligned as well. The strip has consistent unit pitching as verified through Y-indexing until the end of the strip and is aligned on the unit pitching set-up with the singulation program.

On the other hand, Fig. 7 shows aligned first cut line with the machine hairline but cut lines were offset as the strip progress. First cut line was aligned properly with the first cut line, but cut line 15 and cut line 30 has already misaligned hairline with respect to the saw street of the strip. The strip has mismatched unit pitching with the machine set-up as verified through Y-indexing. Accumulation of distance from mismatched unit pitching induces the potential offset cut.

Aside on the frequent assistance of the shopfloor to adjust the hairline, unit pitching of machine set-up to the actual pitching of the units at the strip can be changed through program adjustments. The authors have explored the idea to perform parameter adjustment on the affected strips to find out if it can be effective. Also, as observed with the strip batches, the mismatched unit pitching that was encountered on the first strip was the same with the succeeding strips of the same batch. Thus, adjustments to match the actual unit pitching of the strip to the machine set-up can be performed and utilized per batch of lots.

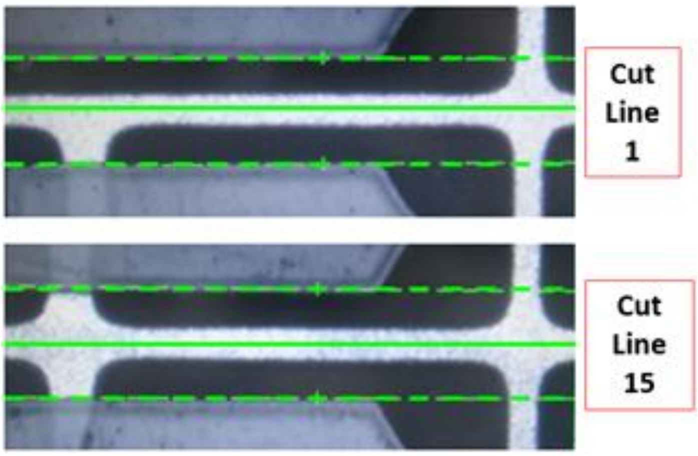

Fig. 6. Aligned hairline and consistent pitching

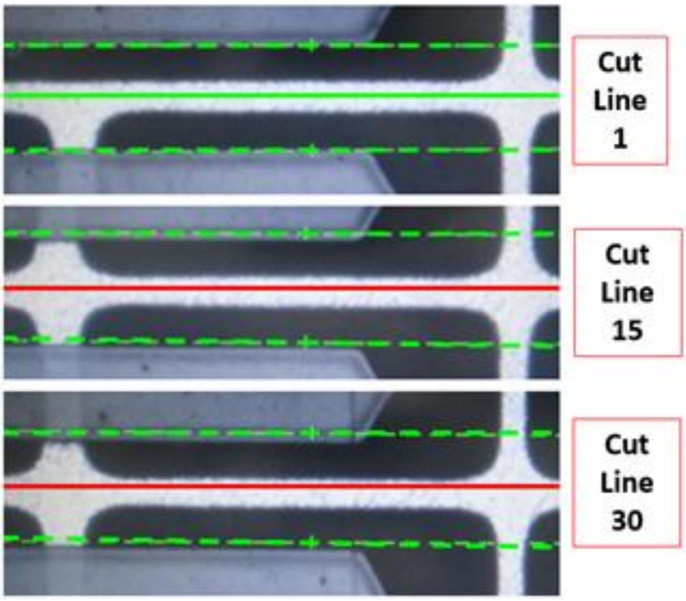

Fig. 7. Cut lines with different response

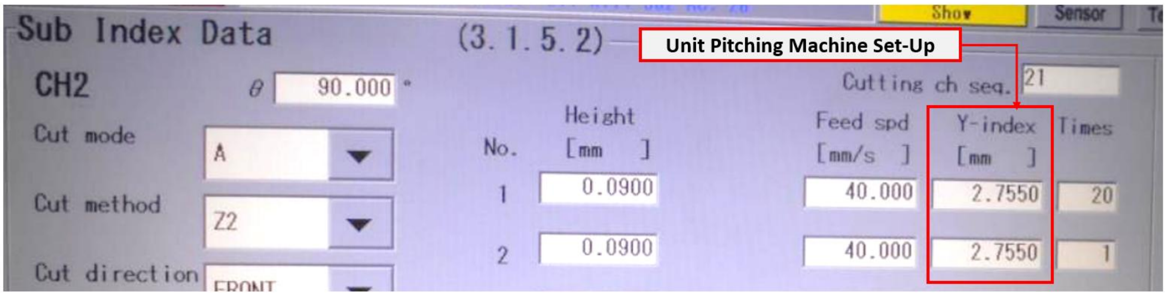

Fig. 8. Sub index parameter page

2.3 Assistance Through Sub-Index Unit Pitch Adjustment

With the strip being verified and predicted to encounter offset cutting as the strip progressed on the singulation process, unit pitching can be adjusted to cater and match the actual unit pitching of the strip. This can be changed through adjusting the value of unit pitch at the sub index parameter page. Sub index data page can be found upon selecting the Device Menu key, then select the Device Program key, and lastly select the Sub Indexing key. Measurement on Y-index section should be changed with the appropriate value according to the actual unit pitching of the strip. Fig. 8 shows the page on the machine where the unit pitch can be changed.

Sub-index on CH1 or CH2 can be adjusted for Y-indexing which corresponds to the unit pitching. The chuck table of the machine which holds the strip moves only upward and downward which corresponds the Y-movement that moves per unit pitch. Blade movement is horizontal which corresponds to the X-indexing.

Strips reacts and differs with the ideal condition after series of assembly process steps was being performed. Thus, considering the good strips was essential to be the reference strip of the new unit pitch adjustment.

3. RESULTS AND DISCUSSION

The methodology that was conducted have assisted the authors to arrive on the results and discussion of addressing the mismatched unit pitching observed during Y-indexing.

3.1 Matching the Unit Pitching

The example of mismatched unit pitching between the program set-up and the actual unit pitch was shown on Fig. 7. Machine program

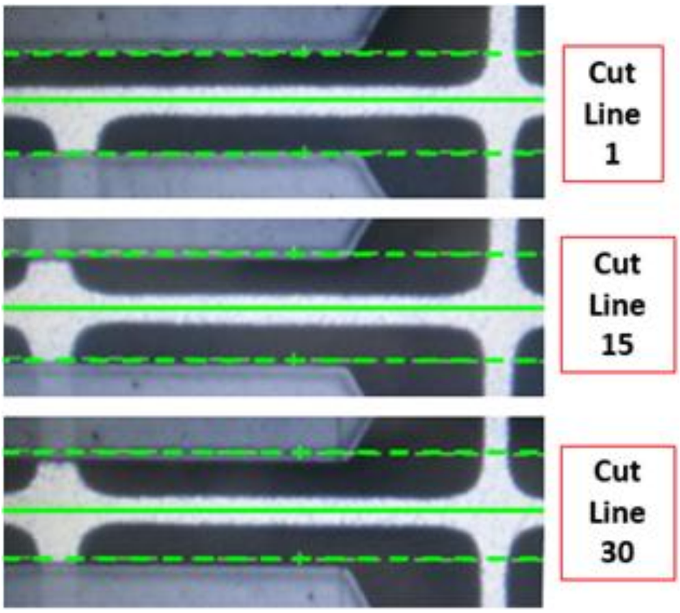

Fig. 9. Matched unit pitching after parameter adjustment

refers to the drawing and ideal dimension of the strip, while the strip has inconsistent response that was induced by the assembly process steps that causes the strips to expand or retract.

Changing the value of unit pitching to match with the actual unit pitching of the strip resolves the potential offset cut issue. For example, the unit pitch at package outine assembly document as well as the machine set up was at 2.750 mm. However, 12 microns were needed to match the actual unit pitching of the strip. The unit pitching machine set-up should be added with 12 microns which results to 2.762 mm. Any value can be inputted on the machine as the unit pitching. Fig. 9 shows that hairline was already aligned with the saw street of the strip from first to last cut line after adjustment of parameter settings.

Matching the actual unit pitching of the strip to the machine program set-up have been verified to be effective approach to avoid offset cuts. Verification of y-indexing together with x-indexing at first cut line is essential to entrap and adjust the parameters as needed.

4. CONCLUSION AND RECOMMENDATIONS

With the study conducted, it has been found out that the occurrence of units affected with gross misaligned cut was brought about by the mismatched unit pitching between the actual strip and machine program. Frequent manual adjustment of hairline to compensate with the actual unit pitching was performed which is tedious and risky to aggravate the occurrence of cutting misalignment.

Actual unit pitching of the strip mismatches with the program due to the expansion and retraction brought about by series of assembly processes before the strip reaches singulation process. It was also observed that mismatched unit pitching occurs per batch of processing. However, mismatched unit pitching can be entrapped upon proactive approach to verify the Y-indexing of the strip before proceeding with singulation. Mismatched unit pitching can be corrected through adjustment of unit pitching at the program set-up to match the actual unit pitching of the strip instead of frequent assistance done during processing of lots.

Through the data collected with the study, the authors concluded that y-indexing verification is essential to be performed as a proactive approach that can prevent gross misaligned cut units brought about by the mismatched unit pitching. Tedious assistance to adjust hairline was also avoided as unit pitching was aligned as early as the first strip cut line was verified.

It is highly recommended to include the Y-indexing verification together with the X-indexing verification that was performed on the first cut line of the strip at singulation. Unit pitching adjustments with the program are important in order to match the actual unit pitching with the hairline. The proactive approach recommended by the authors have also maximized the equipment capability and error-proofing solution without acquiring investment that supports the high-volume manufacturing performance of the assembly plant.

For future works, reliability due to mismatch of thermal expansion could be studied. Studies could be explored and considere on constitutive behaviour and life evaluation of solder joint under the multi-field loadings, thermal fatigue life of Sn–3.0 Ag–0.5 Cu solder joint under temperature cycling coupled with electric current, and mechanics-based acceleration for estimating thermal fatigue life of electronic packaging structure. Lastly, works and studies in [8-11] are helpful in realizing a robust assembly manufacturing process.

DISCLAIMER

The products used for this research are commonly and predominantly used products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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