



Lead Scratch Resolution through Wirebonding Process Optimization on QFN Packages

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Authors' contributions

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

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ABSTRACT

With the continuous trend of new technologies in semiconductor manufacturing assembly, challenges and issues are unavoidable. This paper presents an improvement done in quad-flat no-leads (QFN) leadframe package to resolve the quantity of unit rejection due to leads scratch underneath the leadframe. Moreover, the reject manifestation was captured after wirebonding process. Parameter optimization particularly for the second bond with the combination of bond force and bond scrubbing parameters was done to totally eliminate this type of issue after wirebonding process. With the wirebonding process optimization and improvement done, a reduction of 95 percent of leads scratch occurrence was achieved.

Keywords: QFN; leadframe; wirebonding; bond force; bond scrubbing.

1. INTRODUCTION

One of the greatest trials for semiconductor assembly manufacturing is to maintain its

competitive market position and its value as well. New technologies have a given manufacturability issues encountered during lot processing and one of the particular process mostly affected is

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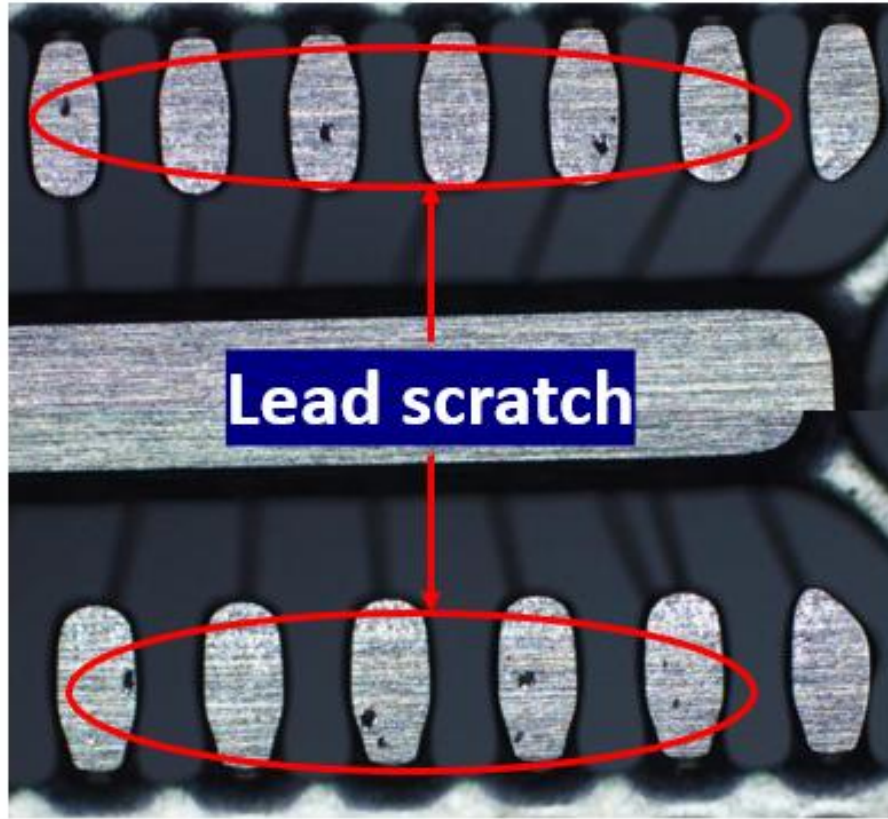


Fig. 1. Lead scratch manifestation

the wirebonding process. Wirebonding process is responsible in attaching the wires to provide electrical connections through combination of heat, pressure and thermosonic energy. This paper presents a solution and improvement done to process this type of assembly reject lead scratch by optimizing the parameter bond force and bond scrubbing. Bond force is the amount of additional pressure applied during the bonding cycle while bond scrubbing is the duration applied through bond forced with heavily pressed on the leads of the leadframe material. To guarantee its integrity during the processing, wirebond process is incorporated with a multiple of criteria such as, ball size, ball height, ball aspect ratio, wire-pull test, ball shear test, stitch-pull test, loop height, intermetallic coverage, contact angle, and visual inspection. This wirebond criteria is performed after machine conversion or set-up to ensure the product is reliable when loaded to a reliability test. Fig. 1 above shows the defect manifestation of lead scratch.

2. LITERATURE REVIEW AND PROBLEM IDENTIFICATION

A complete assembly process flow for quad-flat no-leads (QFN) device in attention from pre-assembly to singulation is illustrated in Fig. 2. Important to note that assembly process flow varies with the product and the technology [1-3]. Furthermore, with new and continuous technology trends and breakthroughs, challenges in assembly manufacturing are inevitable [4-7].

Lead scratch is the top major assembly reject in wirebonding process, and this was seen during the lot processing of the device. This lead scratch is caused by a high bond force and high bond scrubbing during attaching of wires on the leads. One of the most challenging issue in wirebond process is to fine tune the parameter to have a good response in the actual unit and to have a good reliability as well.

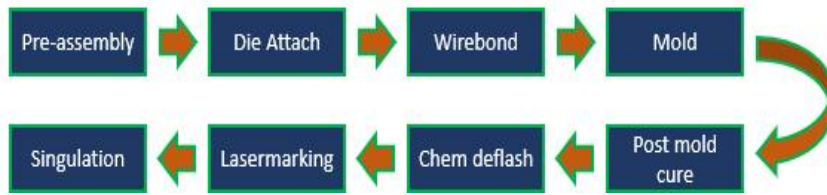


Fig. 2. QFN assembly process flow

3. PROCESS SOLUTION AND DISCUSSION OF RESULTS

An improved and enhanced process solution in wirebonding is widely done with the combination of bond force and bond scrubbing parameter optimization. Fig. 3 illustrates the wirebonding sequence. The wire used is usually made either of gold or aluminum, with copper wires added recently in semiconductor assembly manufacturing industry [4,8].

With the combination of bond force and bond scrubbing parameter optimization, no lead scratch occurrence was seen after implementing the improvement in wirebonding process. Fig. 4 shows the actual unit with no lead scratch using

the optimized bond force and bond scrubbing parameter. With this improvement, backside inspection on the leads is not anymore needed, thus saving resources and time. Furthermore, faster delivery of units and business movement could be realized.

The optimized parameter would eventually have a good reliability test and a good solderability test. This optimized bond parameter would eventually serve as the good stitch formation, shown in Fig. 5, which also passed the destructive wire-pull test. A 95 percent improvement shared in Fig. 6 was achieved for lead scratch. Note that actual parts per million (PPM) level are intentionally not shown due to confidentiality.

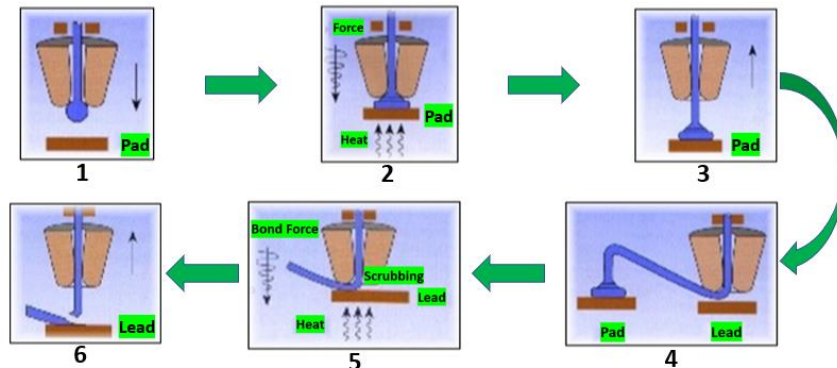


Fig. 3. Wirebonding sequence

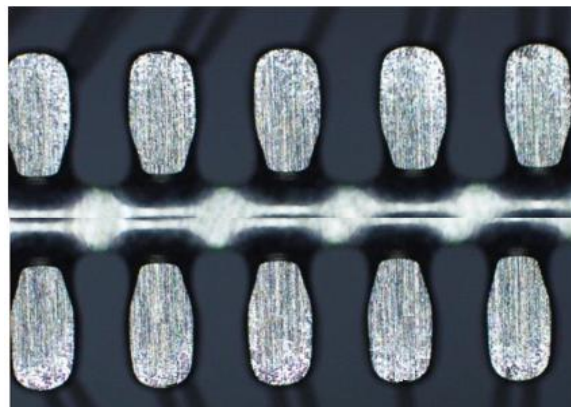


Fig. 4. Actual unit with no lead scratch using the optimized parameter

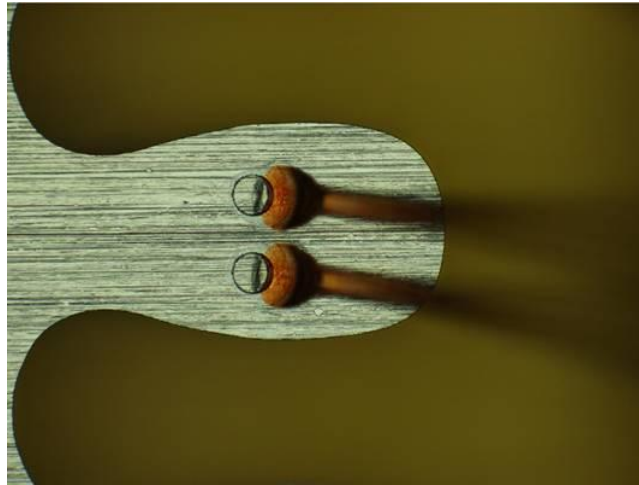


Fig. 5. Actual unit with a good stitch formation

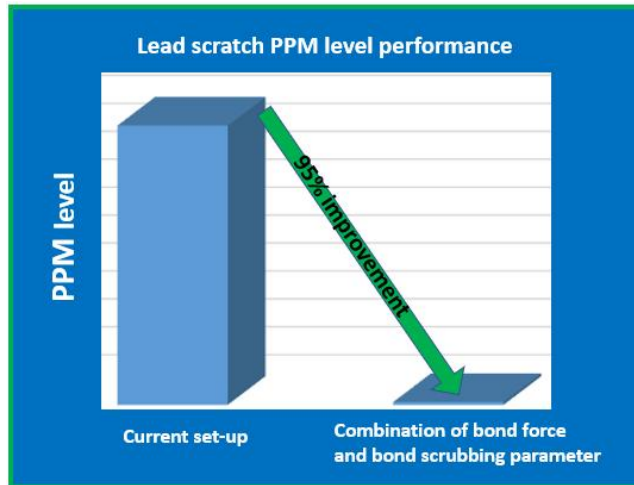


Fig. 6. PPM level performance of lead scratch

4. CONCLUSION AND RECOMMENDATIONS

Lead scratch mitigation was successfully realized through comprehensive wirebond process characterization and optimization for QFN leadframe package. Parameter optimization particularly for the second bond with the combination of bond force and bond scrubbing parameters were employed, resulting to 95 percent improvement on the leads scratch occurrence reduction.

The wirebond parameter optimization in this study could be used for future works on other QFN products with similar configuration. Comparison of existing works and other studies

should also be included for added analysis. Worth noting is that continuous process improvement is really important to sustain the high quality performance of semiconductor products and their assembly manufacturing. Studies and learnings shared in [4,7-11] are helpful in reinforcing robustness and optimization of assembly processes particular at wirebonding process.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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