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Mechanical and Chemical Treatment for Copper Burr Elimination in Wettable Flank QFN

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Abstract— *The creation of a robust wettable flank architecture in quad-flat no-leads (QFN) packages is satisfied by the step-cut configuration, where the exposed sidewall is plated with Sn. The step-cut singulation process induces Cu burrs, which can lead to shorting via physical bridging between leads due to the burr, or the environmentally induced Cu migration during field application. Herein, we show that buffing and chemical deflash successfully eliminated the Cu burrs after step-cut singulation. The processes induce minimal effect of the plating quality thereby showcasing the a potential of buffing as one of the enablers for a robust wettable flank technology.*

Keywords— *Buffing, deflash, wettable flank, step-cut, burr.*

I. INTRODUCTION

Package underside terminations in quad flat no-leads (QFN) device prevent the visually detectable solderable terminations when mounted on board. Due to the susceptibility of Cu package terminations towards oxidation, visual assessment of package solderability becomes a challenge [1-3]. Hence, electrical testing acts as a check for full electrical connectivity along the soldered interfaces. The industry drive towards wettable flank technology to enable visually detectable termination solder joint is primarily mandated by automotive customers. These wettable flanks allow the solder to form fillets, which can be detected via optical inspection, and are indicative of good electrical connectivity.

Step-cut singulation process is one of the enablers of wettable flank technology [4]. However, metal burrs are inherent to the process, which can cause shorting via physical bridging between leads due to the burr, or the environmentally induced Cu migration during field application. Herein, we show that mechanical treatment (buffing) and chemical deflash result in the removal of the burr, and offer a surface ideal for tin electroplating. Solderability assessment of the treated surfaces validated the effectivity of these processes.

II. EXPERIMENTAL DETAILS

Standard QFN package was assembled using standard process involving the attachment of a semiconductor die onto a copper leadframe using a die attach material, electrically connecting the die to the leadframe using a thin wire, and encapsulating the package using an epoxy molding compund. The partial- and full-cut was realized using a commercially available DFD6362HC (NLA219) DISCO Fully Automatic Dicing Saw with LSD. The electroplating process was performed using Stannopure 100 plating chemistry from Atotech. The buffing evaluation was performed using a fully auto buffing machine (BUFF-1001S v3.0) with special customized configuration of stack magazine to slot magazine. Chemical deflash followed by water jet processes were performed using the proprietary chemistry developed for the process. Solderability test was performed following the JEDEC standard (JESD22-B102E) to check the robustness of the solution.

III. RESULTS AND DISCUSSION

The step-cut configuration in a QFN package is shown in Fig. 1. The depth profile imaged and measured using a Keyence laser profilometer exhibited acceptable characteristics in accordance with the product specifications.

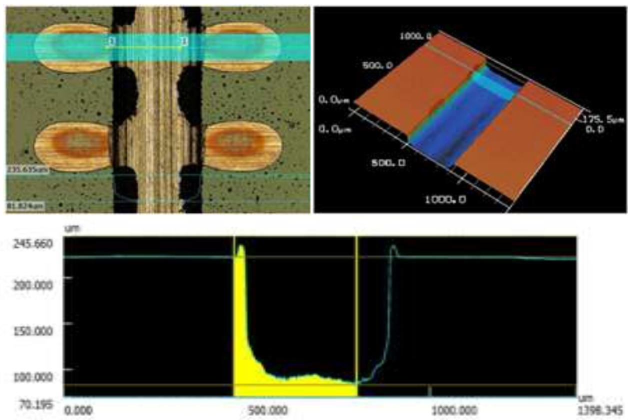

Fig. 1. Partial-cut depth profile.

Burr measurements (Fig. 2) indicate out-of-specification readings, prompting the exploration of physical and chemical interventions to address the problem. Mechanical surface treatment in the form of buffing resulted in the burr removal but left striations on both the metal surface and the epoxy molding compound (Fig. 3a). These signatures are common in mechanical polishing systems, causing cosmetic defects on the package surface. To address this shortcoming, chemical deflash followed by high pressure water jet were explored. Results show (Fig. 3b) significant improvement of the surface morphology both for the metal and organic parts. Total removal of the burr resulted in smoother surface and sharper boundaries of the metal leads. These results indicate the success of mechanical and chemical treatment of step-cut singulated units towards metal burr elimination.

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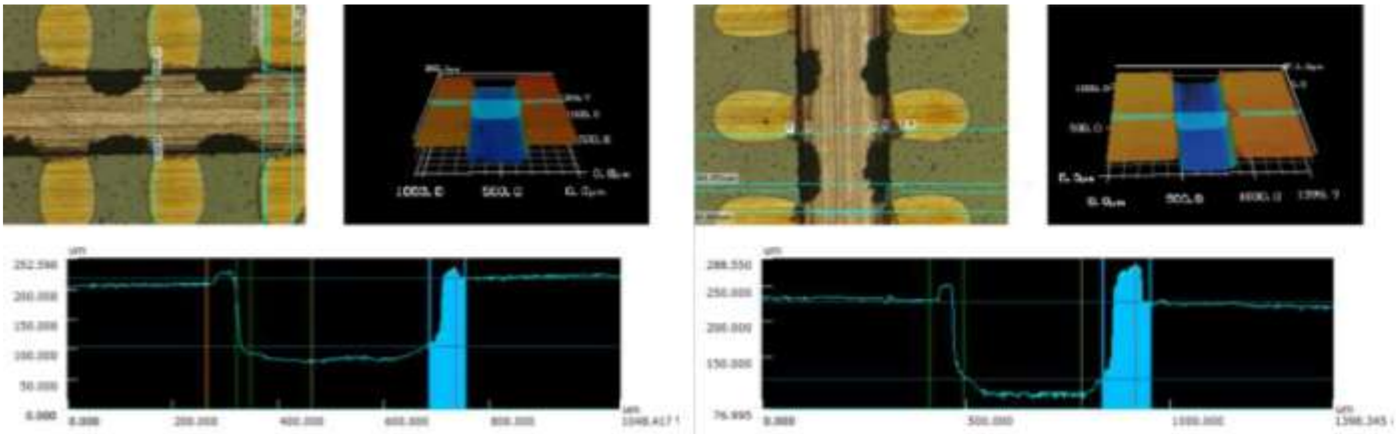

Fig. 2. Representative depth profile where the *x*- and *y*-burr are measured.

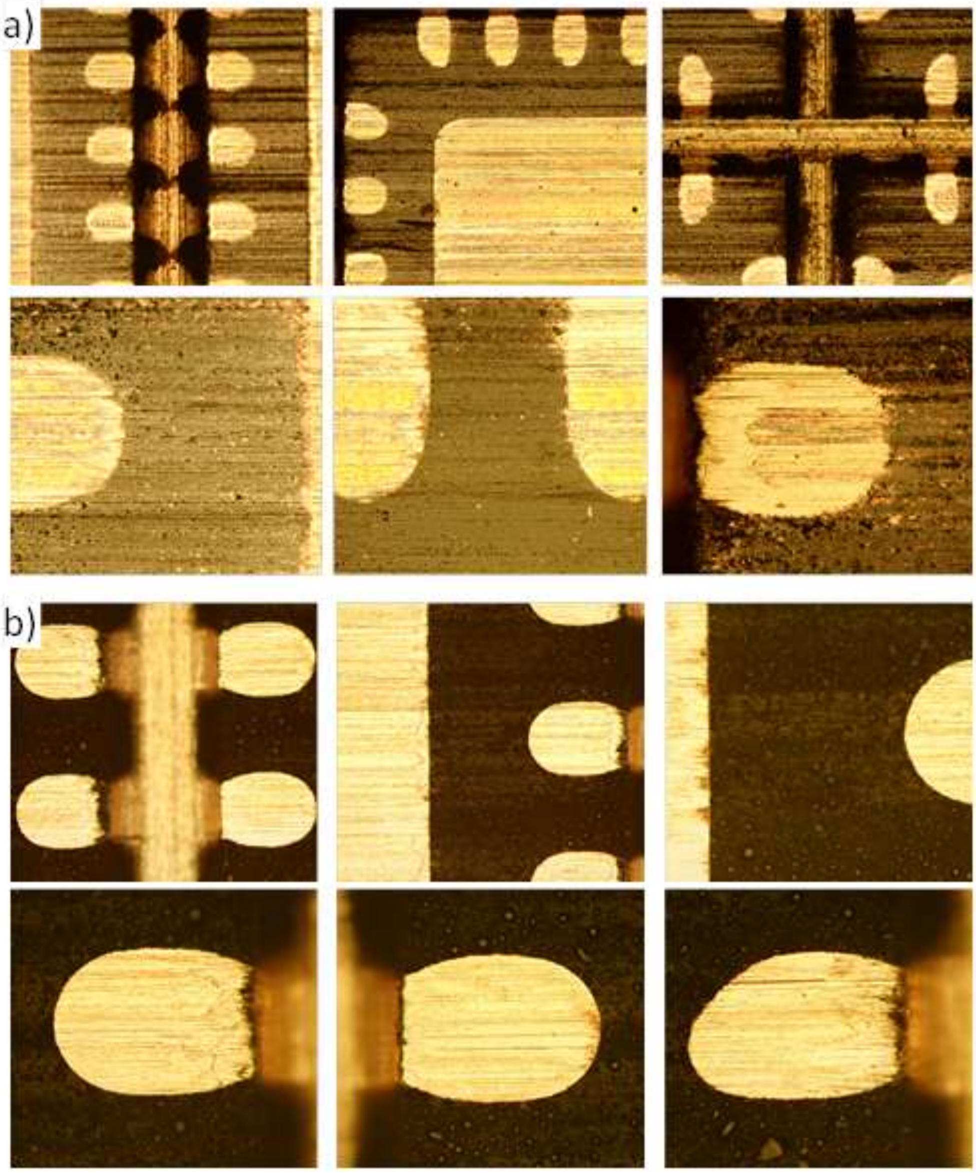

Fig. 3. Representative images of Cu terminations a) after buffing and b) after chemical deflash and water jet process.

To make the exposed metal terminations consistently solderable, tin electroplating was performed after the chemical deflash and waterjet processes. Results show good and even plating appearance, passing the visual inspection. Moreover, the plating thickness requirement was satisfied. Cross-sectional images (Fig. 5) further confirmed the burr removal, and the buffing depth of 12 µm. In addition, units passed the solderability test after 8 h steam ageing and 16 h dry bake.

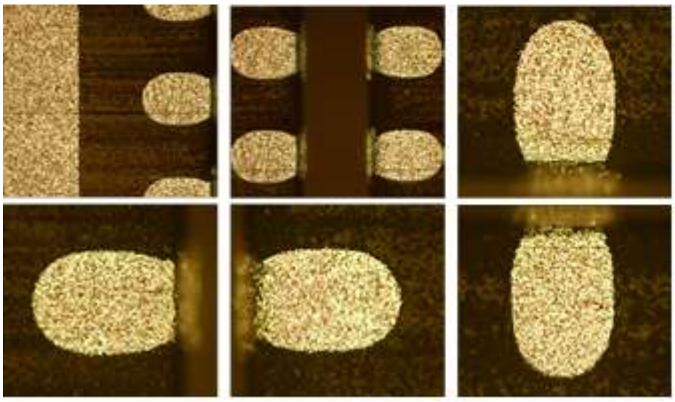

Fig. 4. Surface images after tin plating process.

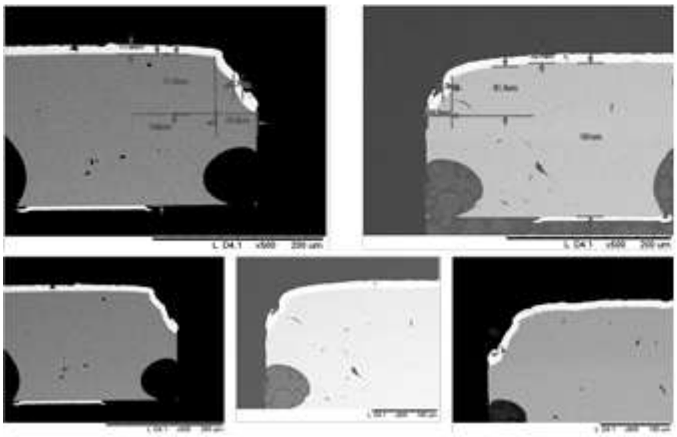

Fig. 5. Cross-sectional images of leads after the treatments and tin plating.

IV. Conclusion

The development of wettable flank QFN relied on the partial- and full-cut mechanical singulation processes, and Sn electroplating process. Mechanical polishing through buffing, followed by chemical deflash and water jet successfully removed metal burrs, and produced surface that can be electroplated with tin for wettable flank technology.

Acknowledgment

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