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Elimination of Intermetallic Coverage Over-etching on Aluminum Pad

Jonalyn Jaylo-Sia[1], Jonathan Pulido[1*] and Frederick Ray Gomez[1]

[1]New Product Development and Introduction, STMicroelectronics, Inc., Calamba City, Laguna-4027, Philippines.

Authors' contributions

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

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ABSTRACT

Intermetallic coverage (IMC) is one of the critical wirebond output responses that is usually checked to ensure the ball to pad integrity. The success of wirebonding relies on the formation of an interfacial intermetallic growth of ball bond to ensure it can withstand reliability stresses. The challenging approach in IMC analysis detect as over-etching around IMC area that leads to inaccurate IMC data collection. To address the over-etching, we generate a new method which is backside polishing that results to a reliable IMC data collection and help reduced the cycle time of IMC data gathering.

Keywords: Acid dripping; backside polishing; intermetallic coverage; over-etching.

1. INTRODUCTION

Wirebonding is the process of providing electrical connection between the Silicon (Si) die and the external leads of the electronic package using very fine bonding wires [1,2]. At present, Gold (Au), Aluminum (Al), and Copper (Cu) are widely used, while Au is the most preferred among them due to its excellent resistance to oxidation. The rise in Au prices has encouraged the use of Cu wire bonding, but the high hardness of Cu hinders its application in thin and fragile Al pads

**Corresponding author: Email: jonathan.pulido@st.com;*

in memory devices. Cu wire is now the state-of-the-art for wirebonding with about 55 to 60 % of packages are bonded using Cu wires. Silver (Ag) wire bonding on Al on the other hand is currently being developed by the industry to address the economic and technical limitations of Au and Cu wires [3,4]. Al pads are still used in the semiconductor packaging industry due to their cost-effectiveness. In recent times, a variety of Ag alloys have been designed for better bonding wire and improved properties [5,6].

Intermetallic compound or intermetallic coverage (IMC) is a type of metallic alloy that forms an ordered solid-state compound between two or more metallic elements. During wirebonding process, it is important to test the integrity of the ball bond to aluminum pad but the challenge on IMC analysis is that the Al pad was encountered over-etching during acid dripping method [7,8]. Before chemical etching, it is required to bake the units in 175 °C for 2 hours to grow the intermetallic of the wire and Al pad. Nitric acid (HNO3) is used for etching process with deionized (DI) water to dissolve the wires and leave the IMC on the bond pad [7,9,10]. Herein, we report the effective method of IMC analysis and the solution to be used to address the over-etching issue on the Al pad.

2. METHODS AND RESULTS

The wires used in the study were bonded to AlCu pads with 1.45 µm thickness using optimized parameters established using standard design of experiment procedures. No abnormality was encountered during the wirebonding process. The wire bonded samples were process for thermal ageing for 2 hours at 175 °C to form intermetallic growth between the ball and Al pad interface. The process of acid etching method shown in Fig.1 where the solution used has a ratio of 1 part of DI water and 1 part of nitric acid 69 %.

After etching, rinsing with DI water and acetone to stop the acid reaction then drying with air gun before inspection. As a result, Si layer already exposed after etching process shown in Fig. 2, thus evaluation of etching time and unit positioning was performed to control over etching but still exposure of underneath layer can still be observed.

Through backside polishing method, the over-etching of IMC was eliminated by replacing the previous etching solution to a specialized chemical solution which only etch the Al pad. In Fig. 3, it shows the new procedure generated for IMC of the wire where the samples

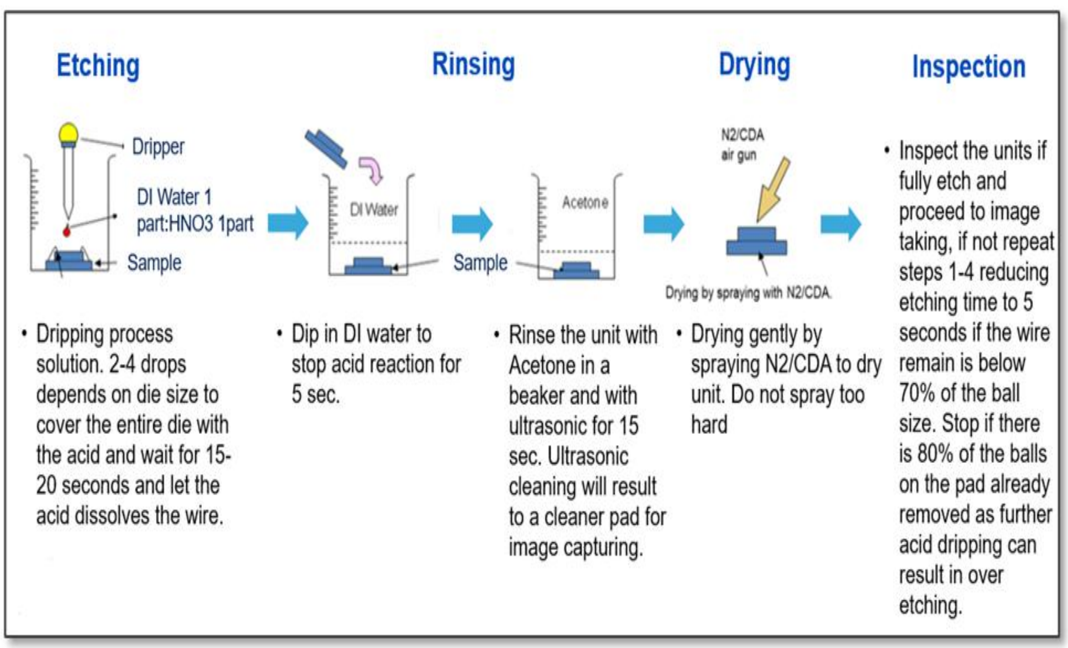

Fig. 1. Acid dripping method

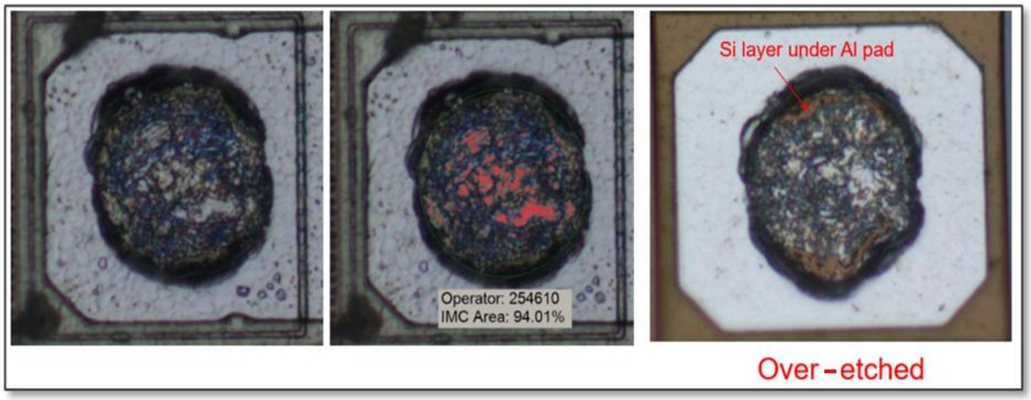

Fig. 2. Result of acid dripping method

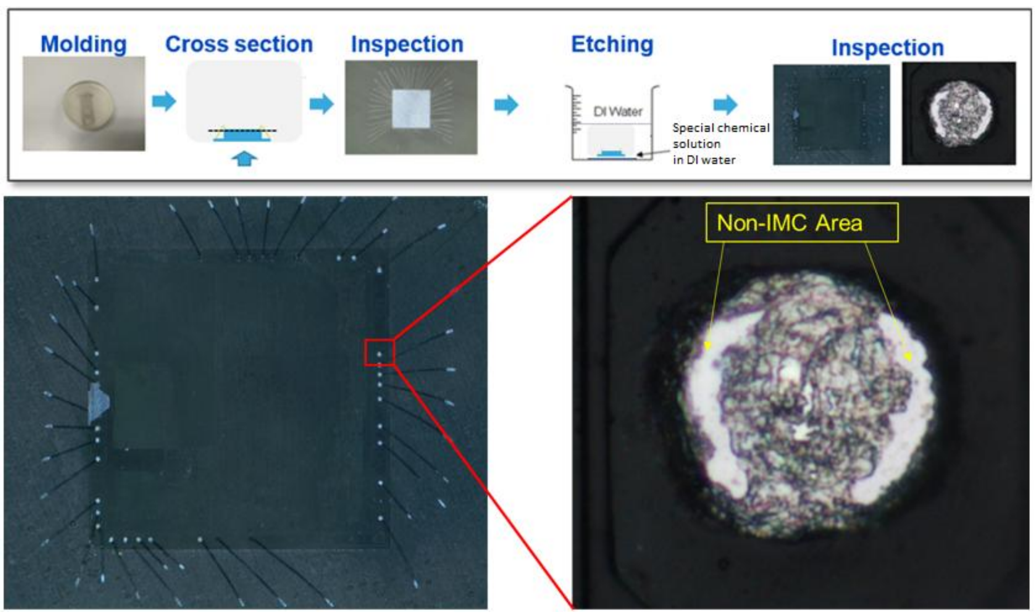

Fig. 3. Backside polishing method

were molded by the resin as a holder for polishing then the solution and DI water will penetrate inside the sample. The chemical will etch the Al pad for 5 minutes then the backside of the ball will remain where the IMC area are visible without over-etching.

3. CONCLUSION AND RECOMMENDATIONS

With the implementation of backside polishing method of IMC analysis, the over-etching was resolved with quality and reliable data gathered. This also reduced the repetitive activity which entails productivity and cost. For future works, the effect of nitric acid to wire-to-Al pad should be explored and studied based on the Al thickness since acid dripping method is using the same solution for other IMC analysis. Experimental conditions for the normally etched, under-etched and over-etched samples should also be presented for better visualization and discussion.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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