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Microvoid Growth in the Interfaces during Aging

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Abstract : Microvoids, sometimes called Kikendall voids, generally form in the interfaces between Sn-based solders and Cu and degrade the mechanical and electrical properties of the solder joints. The microvoid formation is known as the rapid interdiffusion between Sn and Cu and impurity content in the Cu. Cu electroplating from the acid solutions has been widely used by microelectronic packaging industry for both printed circuit board (PCB) and integrated circuit (IC) applications. The quality of electroplated Cu that can be optimized by the electroplating conditions is critical for the solder joint reliability. In this paper, the influence of electroplating conditions on the microvoid growth in the interfaces between Sn-3.0Ag-0.5Cu (SAC) solder and Cu layer was investigated during isothermal aging. The Cu layers were electroplated by controlling the additive of electroplating bath and current density to induce various microvoid densities. The electroplating bath consisted of sulfate, sulfuric acid, and additives and the current density of 5-15 mA/cm2 for each bath was used. After aging at 180 °C for up to 250 h, typical bi-layer of Cu6Sn5 and Cu3Sn intermetallic compounds (IMCs) was gradually growth at the SAC/Cu interface and microvoid density in the Cu3Sn showed disparities in the electroplating conditions. As the current density increased, the microvoid formation was accelerated in all electroplating baths. The higher current density induced, the higher impurity content in the electroplated Cu. When the polyethylene glycol (PEG) and Cl- ion were mixed in an electroplating bath, the microvoid formation was the highest compared to other electroplating baths. On the other hand, the overall IMC thickness was similar in all samples irrespective of the electroplating conditions. Impurity content in electroplated Cu influenced the microvoid growth, but the IMC growth was not affected by the impurity content. In conclusion, the electroplated conditions are properly optimized to avoid the excessive microvoid formation that results in brittle fracture of solder joint under high strain rate loading.

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