Hi-Temperature Lifetime Capability of CuAl Intermetallic Joints: Comparative Study of Pure and Alloyed Copper Wires through Electrical and Physical Methods

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In wire bonding interconnections, copper has replaced gold due to its cost and performance advantages, particularly when coupled with aluminum bond-pads. Alloyed copper wires can further improve reliability performance. This study investigates how the wire alloying elements can affect the time to wear-out of the Inter-Metallic Compounds (IMCs) between Cu wire and aluminum bond-pads when submitted to extended isothermal ageing (HTS). In previous work, a delaying effect of the alloying elements on the IMC evolution was observed through electrical resistance drift (Fig. 1a), but the ageing level reached was not sufficient to detect loss of integrity in the joint, which characterizes the wear-out stage. The investigation has therefore been continued through destructive Wire Pull Test (WPT) and inspection of cross-sectioned samples by SEM (Fig. 1b) and TEM to monitor the structural evolution of the joints in front of an extension of the HTS trials until 10000 equivalent hours at 150°C. IMC stoichiometry has also been studied on TEM lamellas through EDX tools (Fig. 1c) when the typical wear-out symptoms have been detected. The results confirmed the lifetime advantage hypothesized in the previous study for alloyed Cu, with a significant benefit for Hi-rel applications and aggressive geometry scale-down needing adoption of very thin wires. The electrical resistance drift, analyzed until the end of the experiment, did not provide evident signatures correlated with the physical wear-out observed in the joints, and this aspect may deserve further investigation. On the other hand, this non-destructive method has been demonstrated to be an effective early predictor of the lifetime potential if applied in a comparative approach between different materials. It can also be used to estimate the temperature acceleration factor of the degradation mechanism with an accuracy comparable to the rigorous method based on IMC thickness data, which requires a much higher experimental effort.

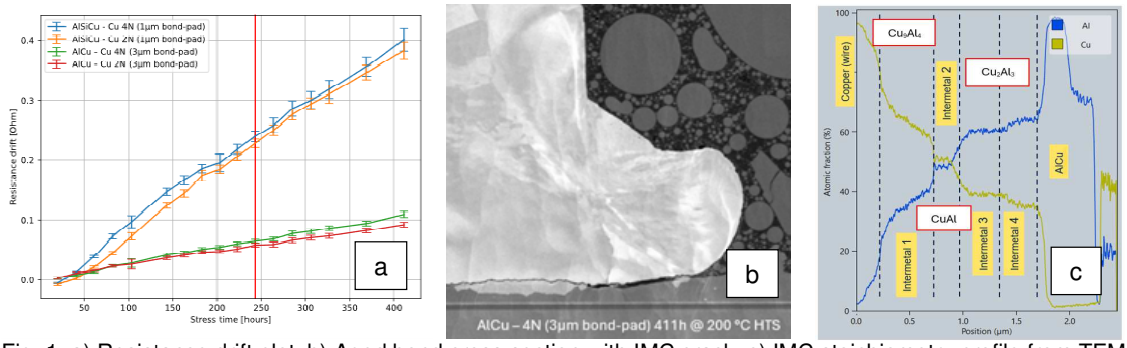

Fig. 1: a) Resistance drift plot, b) Aged bond cross section with IMC crack, c) IMC stoichiometry profile from TEM

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