Impact of aluminium addition on the corrosion behaviour of Sn–1.0Ag–0.5Cu lead-free solder


The effect of Al on the corrosion resistance behaviour of Pb-free Sn–1.0Ag–0.5Cu–xAl solder (x = 0.2 wt%, 0.5 wt% and 1.0 wt%) in 5% NaCl solution was investigated by using potentiodynamic polarization and salt spray exposure. Passivation behaviour was evident in all the solder formulations containing Al, compared to the base SAC solder. FESEM and XRD results revealed that more dense passive films were formed on the solder containing Al, compared to the base solder. These passivation films contained intermetallic compounds such as Al2O3, AlCu3O5, SnO and SnO2 served to further react further to the material. Surface analysis studies showed that the corrosion rate was 30% and 6% lower for alloys with 0.5 wt% and 0.2 wt% Al content, respectively, even though the corrosion potential shifted towards more negative values. The Al-added solder alloys exhibit more refined surface after exposure in the salt spray chamber and revealed no visible infiltration of aggressive ions at the solder–substrate joint. This work suggests a corrosion mitigation strategy for SAC 105 solder through doping of Al.

In previous work, Al-bearing SAC105 was shown to be advantageous in terms of its resistance against thermal aging, improvement of wettability and unaltered IMC thickness tested at high temperature. Consequently, despite the reactivity of Al as an individual metal, Al addition in low-Ag solder alloy improves some key characteristics of the material.**

Generally, solders are used as electronics packaging components in various applications, such as mobile electronics, automobile, and circuitry. Solders are subject to environmental degradation caused by humidity, weather, climatic condition, oceanic environment and thermal changes. The impact is twofold when solders are exposed towards air moisture and industrial contaminant, which often contain aggressive corrosion agents, such as sodium chloride (NaCl) ions. Solder materials must be studied for its resistance and behaviour towards such corrosion agents to be robust.** An immediate consequence is in our handheld gadgets, in which perspiration of consumers provides conductive and corrosive media, given that sweat contains a percentage of chloride at a low pH. The effect may range from being mild in a normal environment to critical in harsh environments. Various mechanical properties will significantly be affected after prolonged exposure to such corrosive environment. Naturally, corrosion is aggravated by the presence of chloride ions, which cause pit nucleation, the presence of humidity, which causes galvanic corrosion, and the dehydration (drying) phase, which traps chloride ions beneath the corrosion by-products. Corrosion rate is defined to be proportional to the metal etched per year (millimetre per year, mmyp). Uniform corrosion, pitting, galvanic and intergranular corrosion are all likely to happen to binary, ternary, quaternary and other