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Relationship of Mechanical and Micromechanical Properties with Microstructural Evolution of Sn-3.0Ag-0.5Cu (SAC305) Solder Wire Under Varied Tensile Strain Rates and Temperatures

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A characterization of mechanical and micromechanical properties of SAC305 solder wire under varied strain rates and temperatures was performed using tensile and nanoindentation tests. The evolution of SAC305 lead-free solder wire grains was compared in samples that were subjected to various strain rates and temperatures using tensile tests based on ASTM E12 standards. Different behaviours of mechanical properties, micromechanical properties, and microstructure evolution of SAC305 solder wire were observed when either temperature or strain rate was held constant and the other varied. Both tensile and nanoindentation tests produced qualitative results, such as dynamic recovery and occurrence of pop-in events, that reflected changes of microstructure. It was observed that some of the mechanical properties of SAC305 solder wire, namely yield strength (YS), ultimate tensile strength (UTS) and Young's modulus, showed the same trends, but with lower values, compared to micromechanical properties obtained from nanoindentation tests based upon hardness and reduced modulus. Microstructure examination further confirms that the YS, UTS and hardness values increase with more solder wire grain refinement. SAC305 solder wire also maintained an equiaxed structure under various strain rates and temperatures.

Key words: Lead-free solder SAC305, mechanical properties, micromechanical properties, nanoindentation, tensile test, microstructure

INTRODUCTION

For the last four decades, solder alloy is still widely used as the means of interconnection for microelectronics. This is due to the maturity and reliability of the solder alloy interconnection.[1–3] Recent trends require microelectronics interconnections to be more cost effective and miniaturize to a smaller size, which introduces challenges related to manufacturability, integrity and reliability of solder alloys. Introduction of new alloys of different types, sizes and shapes has created a different outlook with regard to the microstructure and mechanical properties of solder.

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