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Investigation of the Mechanical and Thermal Properties of a Silver Oxalate Nanoporous Structured Sintered Joint for Micro-joining in Relation to the Sintering Process Parameters

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Abstract : With highly demanding applications in the field of power electronics, there is an increasing need to have interconnection materials with properties that can ensure both good mechanical assembly and high thermal/electrical conductivities. So far, lead-free solders have been considered an attractive solution, but recently, sintered joints based on nano-silver paste have been used for die attach and have proved to be a promising solution offering increased performances in high-temperature applications. In this work, the main parameters of the bonding process using silver oxalates are studied, i.e., the heating rate and the bonding pressure mainly. Their effects on both the mechanical and thermal properties of the sintered layer are evaluated following an experimental design. Pairs of copper substrates with gold metallization are assembled through the sintering process to realize the samples that are tested using a micro-traction machine. In addition, the obtained joints are examined through microscopy to identify the important microstructural features in relation to the measured properties. The formation of an intermetallic compound at the junction between the sintered silver layer and the gold metallization deposited on copper is also analyzed. Microscopy analysis exhibits a nanoporous structure of the sintered material. It is found that higher temperature and bonding pressure result in higher densification of the sintered material, with higher thermal conductivity of the joint but less mechanical flexibility to accommodate the thermo-mechanical stresses arising during service. The experimental design allows hence the determination of the optimal process parameters to reach sufficient thermal/mechanical properties for a given application. It is also found that the interphase formed between silver and gold metallization is the location where the fracture occurred after the mechanical testing, suggesting that the inter-diffusion mechanism between the different elements of the assembly leads to the formation of a relatively brittle compound.

Keywords : nanoporous structure, silver oxalate, sintering, mechanical strength, thermal conductivity, microelectronic packaging
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