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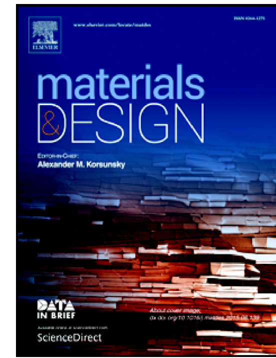

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Bonding through novel solder-metallic mesh composite design

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Abstract

Thin metallic Cu and Ni meshes were successfully embedded within SAC305 solder joints. Defects (residues) within the joint were removed by a vacuum step in the bonding sequence. The metallic mesh inlets were metallurgically bonded by the formation of scallop-like Cu_6Sn_5 and faceted Ni_3Sn_4 intermetallic compounds (IMCs) at the Cu mesh-SAC305 solder (CMS) and Ni mesh-SAC305 solder (NMS) interfaces, respectively. After process optimization, the averaged shear strengths were found to be 44.1 (reference), 44.7 (+ 1%), and 51.4 MPa (+ 16%) for SAC305, NMS, and CMS composite joints, respectively. The solder-substrate-mesh interaction resulted in a characteristic fracture pattern, with the cracking path partly within the solder and partly at the solder-mesh interface. Finite element (FE) simulations suggested a mesh-induced stiffening effect of the solder joint by 5%. The additional reinforcement (11%) introduced by the Cu mesh inlets was attributed to a locally enhanced fracture resistance.

Keywords: solder-mesh composite joints, microstructure, shear strength, finite element modeling, fracture

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Highlights

- Thin Cu and Ni meshes were integrated in SAC305 solder layers
- The metallic meshes were bonded by the formation of intermetallic compounds
- Composite joints provided shear strengths up to 16 % higher
- Reinforcement was achieved by stiffening and a locally increased fracture resistance

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