Nanocomposite SAC solder joints: the effect of heat treatment on the morphology and mechanical properties of Sn-3.0Ag-0.5Cu solder joints reinforced with Ni and Ni-Sn nanoparticles

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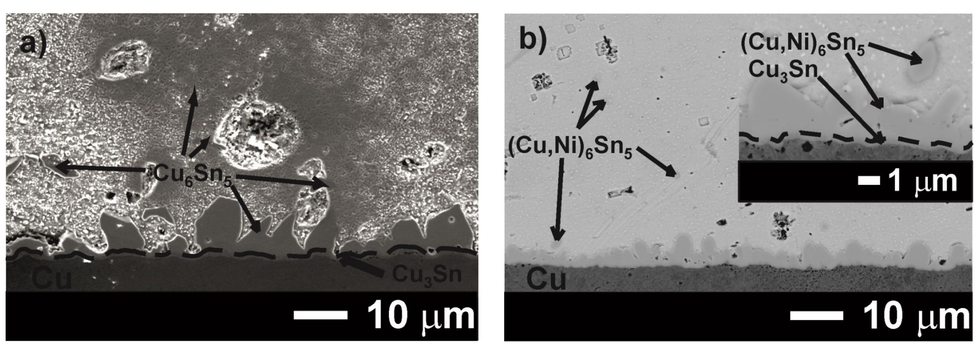
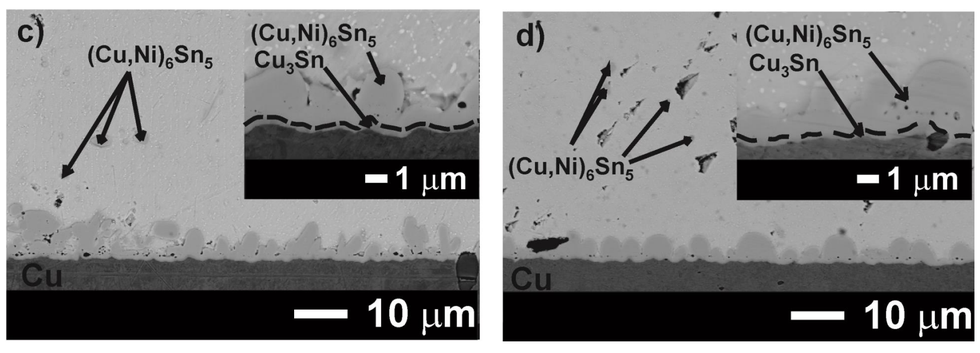
Experimental procedure

The microstructure and shear strength of a Sn-3.0Ag-0.5Cu solder joint (in wt.%) with minor additions of Ni or Ni-Sn nanoparticles were studied. The nanocomposite Sn-3.0Ag-0.5Cu (SAC305) solders were prepared through a paste mixing method. The Ni, Ni_3Sn or Ni_3Sn_2 nanopowders were produced via a chemical reduction method. A nominal percentage of 0.5, 1.0 and 2.0 wt.% of nanosized powder (related to the mass of the solder in the paste) was mechanically blended with the solder paste for at least 30 min to form nanocomposite solders. The as/prepared nanocomposite solder paste was placed on Cu plate. The Cu/solder/Cu holders were placed into an electric resistance furnace, and the joints were prepared in air atmosphere by heating at 523 K for 300 s. After the reflow, the solder joints were cleaned to remove any flux residue. The as-reflowed solder joints were placed in a muffle furnace and kept at 150 ^{0}C for 10 or 20 days.

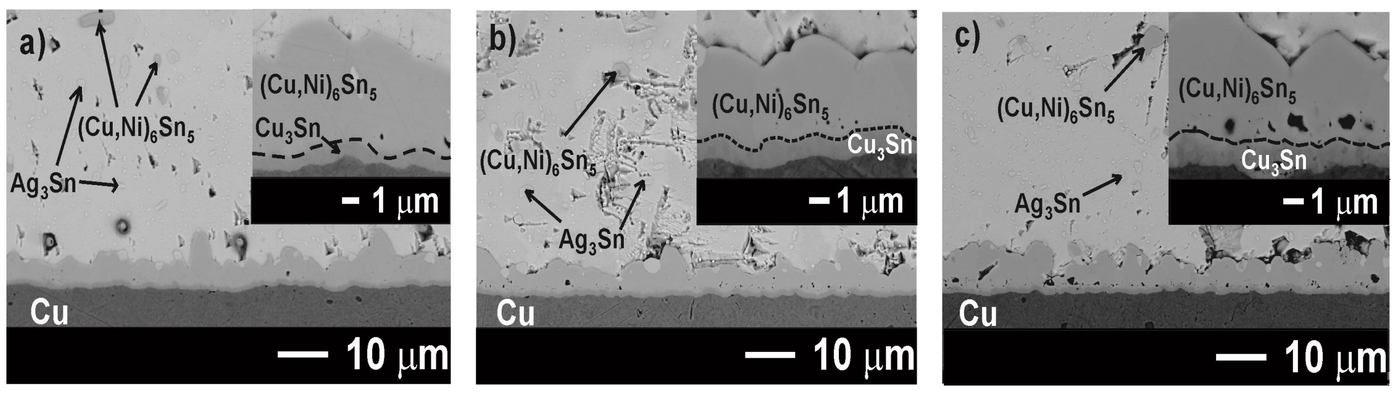
One part of the samples was cross sectioned and polished with 1 μm and 0.3 μm Al_2O_3 powders for microstructure analysis. The microstructure of the joints was studied by scanning electron microscopy (SEM; JEOL JSM-7600F equipped with Energy Dispersive X-ray analyzer (EDX) Oxford Instruments. Another part of the produced samples was used for measurements of mechanical properties. The shear strength studies were performed by the push-off method (Zwick/Roell Z 100), employing a shearing speed of $1{\cdot}10^{-3}$ m·min^{-1}. The microhardness tests were carried out using a Microhardness Tester FM-100 (Future-Tech Corp.).

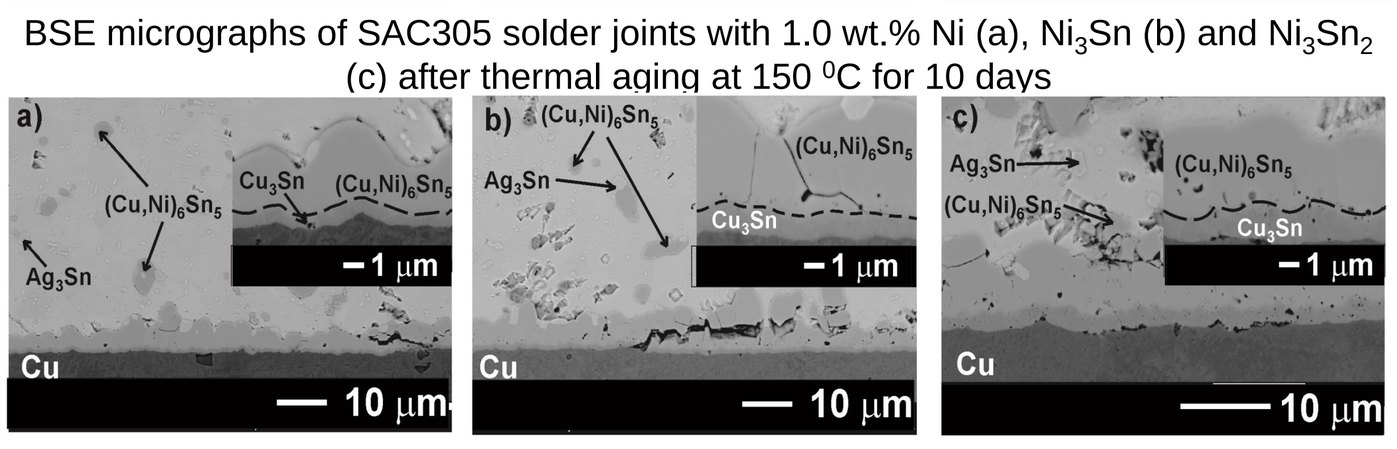
Microstructural analysis





BSE micrographs of as-solidified SAC305 (a) and SAC305 solder joints with 1.0 wt.% Ni (b), Ni_3Sn (c) and Ni_3Sn_2 (d)

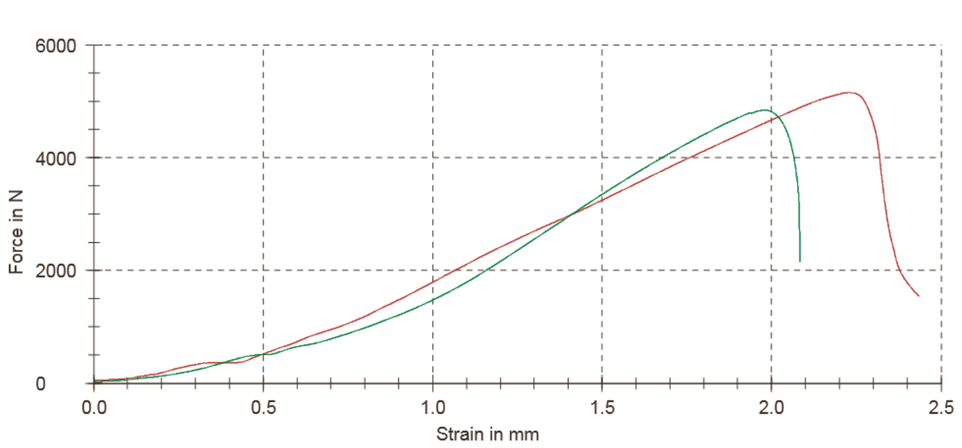


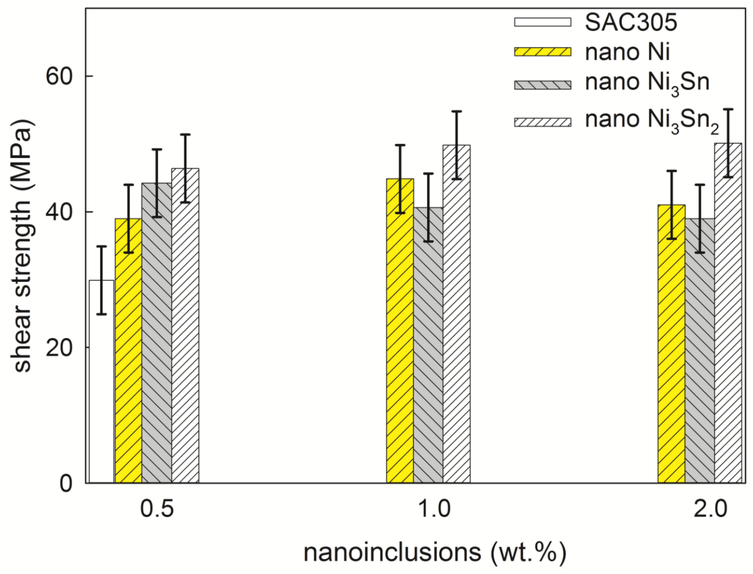


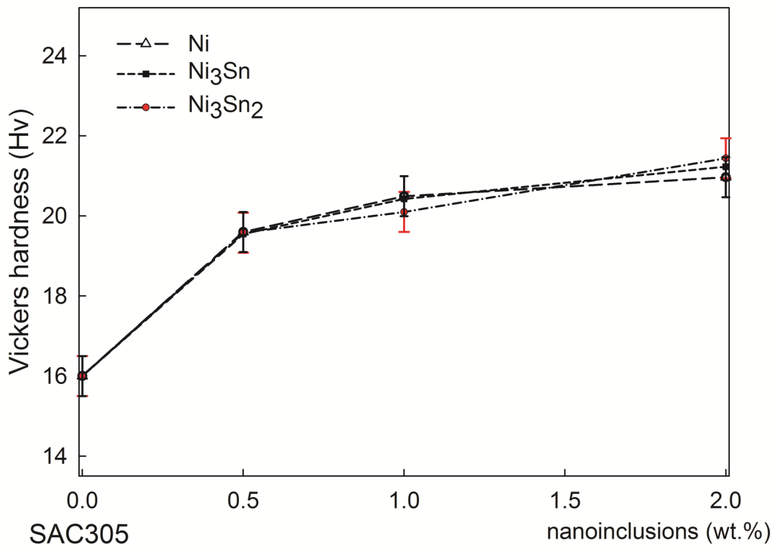
BSE micrographs of SAC305 solder joints with 1.0 wt.% Ni (a), Ni_3Sn (b) and Ni_3Sn_2 (c) after thermal aging at 150 ^{0}C for 10 days

BSE micrographs of SAC305 solder joints with 1.0 wt.% Ni (a), Ni_3Sn (b) and Ni_3Sn_2 (c) after thermal aging at 150 ^{0}C for 20 days

Mechanical properties (*)







Acknowledgements

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Literature

(*) Yakymovych A., Švec P., Orovcik L., Bajana O., Ipser H. J. Electron. Mater. 47 (2018) 117–123. https://doi.org/10.1007/s11664-017-5834-9