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A Mössbauer spectroscopy study of nanoscale Ge–Sn dispersions prepared by ball milling

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Nanoscale mixtures of Ge/Sn, a nominally immiscible binary system, prepared by mechanical attrition have been studied by ^{119}Sn Mössbauer spectroscopy. The Mössbauer measurements in general reveal two sites for the Sn atoms, a tetragonal β–Sn site and another site designated as ‘‘A’’. The β–Sn integrated intensity decreases in magnitude with Ge concentration, 1-x, in $Ge_{1-x}Sn_x$ as the second A-site intensity increases. The isomer shift and the small/negligible quadrupole splitting of site A suggests it represents Sn in solid solution in the Ge lattice. This in turn represents a large (12–24 at.%) nonequilibrium solid solubility of Sn in Ge prepared by mechanical milling, compared to the equilibrium value of < 1.0 at.%. Oxidation of the Sn was detected by Mössbauer spectroscopy at Sn-poor concentrations ($x \leq 0.10$) when the milling vial was not totally free of oxygen (i.e., milling in impure argon). This may be due to rapid oxidation of finely divided Sn film particles possessing a large surface to volume ratio at these compositions.

Keywords: Composites; Microstructure; Powder metallurgy

Materials: Ge/Sn

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