New Nanocomposite Materials for Liquid Metal Coolants

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Abstract. The physical properties of liquid alloys based on the eutectic Bi–Pb composition have attracted considerable scientific interest due to their potential application in next-generation safe small nuclear reactors [1–3]. The selection of a liquid-metal coolant that operates in direct contact with both the reactor core and heat exchangers is of fundamental importance. Such coolants must satisfy a set of stringent requirements, including a low neutron absorption cross section over a wide energy range and a minimal activation cross section from fast to thermal neutrons; low neutron scattering cross section; high heat capacity and thermal conductivity; a high boiling point combined with a low melting temperature; low vapor pressure; cost-effectiveness and availability; chemical compatibility with structural materials of the primary circuit; and long-term thermal stability of properties to prevent local overheating and structural inhomogeneity. In addition, the coolant should be non-toxic and environmentally safe. Potential operational risks are largely associated with the temperature dependence of the microstructure and physical properties of these alloys. In this study, the electrical and transport properties of eutectic and near-eutectic Bi–Pb and Bi–Pb–Sn (Zn) alloys were investigated over a broad temperature range, from room temperature to the liquid state. The influence of phase transformations on the temperature dependence of resistivity in the melting and solidification region was analyzed.

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