LOW MELTING TEMPERATURE LANTHANUM-LEAD-BISMUTH ALLOYS

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As a chemical element, La appears in many electronic applications, including superconductors, most notably LaH_{10}, which holds the record for a superconducting transition temperature of 230 K [1]. The fabrication of surface-engineered devices containing La sometimes requires handling the element in a solid form protected from atmospheric exposure. Elemental La is highly chemically reactive; however, when dissolved in alloys, it becomes protected against oxidation. In this work, La was incorporated into a so-called metal-flux alloy of Pb–Bi (45:55) at a much lower temperature (<300 °C) than the melting temperature of pure La (>900 °C). The resulting metal mixture demonstrates chemical stability against oxidation. Structural analysis using SEM, EDX, and XRD revealed non-equilibrium behavior of the melted alloys (in the temperature range of 180–420 °C), accompanied by elemental reorganization into more stable phases, namely Bi_2La (melting temperature 932 °C) and $Pb_{70}Bi_{30}$, as shown in Fig. 1. The newly developed soft La–Pb–Bi alloy enables safe handling and machining of La-rich materials at room temperature and opens new kinetic pathways for La–Bi phase formation, diffusion bonding, cold alloying, and liquid-metal-based delivery of La to substrates.

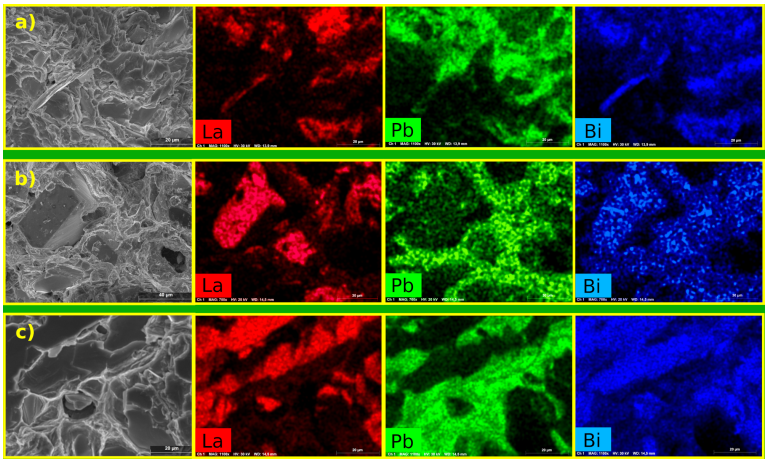

Fig. 1. Fig. 1. Visualization of chemical element distributions by SEM–EDX for three different alloys with La contents of 10 wt% (a), 20 wt% (b), and 22 wt% (c). Darker regions correspond to lower concentrations of the given element.

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Keywords: Superconductors, Alloys

[1] A. P. Drozdov et al., "Superconductivity at 250 K in lanthanum hydride under high pressures," Nature, vol. 569, no. 7757, pp. 528–531, May 2019, doi: 10.1038/s41586-019-1201-8.