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ORIGINAL PAPER

Comparing the Effects of Nb, Pb, Y, and La Replacement on the Structural, Electrical, and Magnetic Characteristics of Bi-Based Superconductors

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Abstract

In this study, the effects of Pb, Nb, La, and Y replacements were investigated on Bi-based superconducting materials. In preparing the samples, we used a method called solid-state reaction method. The patterns of the X-ray diffraction of all samples indicated presence of Bi-2212 and Bi-2223 phases. The results obtained from XRD revealed that with increase of the melting point of substation elements, the Bi-2223 phase decreased while the Bi-2212 phase and impurity phases of samples grew. From the electrical resistivity measurements using the four-probe method, it was found that sample A with Pb and sample B with La replacements had the maximum and minimum critical temperatures of 111.4 and 81.6 K, respectively. Based on hysteresis loop (M–H) measurement using Bean's model, estimation of critical current density (J_c) showed that sample A with Pb and sample B with La substitution had the maximum and minimum values respectively. These results may be due to the melting point of these elements with values of 888, 1512, 2315, and 2425 °C for PbO, Nb_2O_5, La_2O_3, and Y_2O_3, respectively. These elements were replaced by Bi_2O_3 with a melting point of 817 °C. Further, the samples were prepared at the temperature of 845 °C. It seems at this temperature, these elements not only dissolve within the main matrix and participate in the formation of the Bi-2212 phase during the sintering process but they also participate in the development of the variety of the impurity phases as confirmed by XRD results.

Keywords Bi-based superconductors · Volume fraction · Critical temperature · Four-point probe method · Lattice parameters · p parameter

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