

Comparison-Comparing of 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 replacement were investigated on the Bi-based superconducting materials. In preparing the samples, we used a method which is called solid-state reaction method. The patterns of the X-ray diffraction of all samples indicated the presence of Bi-2212 and Bi-2223 phases. The -Obtained results obtained from XRD, indicated-revealed that with increasing of the melting point of substitution elements, the (Bi-2223) phase decreases-decreased, and while the (Bi-2212) phase and impurity phases of samples increase-grow. From the electrical resistivity measurements using the four-probe method, it has been-was found that sample A with Pb and sample B with La replacements had the maximum and minimum critical temperature of 111.4 K and 81.6 K, respectively. From-Based on hysteresis loop (M-H) measurement by using Bean's model, estimating-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 amounts-values of 888 °C, 1512 °C, 2315 °C, 2425 °C for PbO, Nb₂O₅, La₂O₃ and Y₂O₃ respectively. These elements were substituted-instead of-replaced by Bi₂O₃ with a melting point of 817 °C. In this study-for this, 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 appearance-development of the variety of the impurity phases which-is confirmed by XRD results. In the BSCCO system, for further formation of the (Bi-2223) phase, the partial melting point of the composing elements must be close to the sintering temperature of the samples of BSCCO system.

Keywords

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

1. Introduction

Addition or substitution-substitution in Bismuth-based superconductors as a probe is used for determining whether they exhibit better superconductivity properties or not. From-Since the time of Bi-based superconductors have been discovered [1], a lot-great deal of research has been done by researchers from all over the world [2-10]. The researchers are-have been trying to improve the superconductive properties and make-better understanding of the structural characteristics of the superconductors. Activities such as substitution and addition of a variety of elements have been done by researchers, so that determine-determine whether the superconductivity properties of this type of HTSC gets-better-improve or worse-worsen. BSCCO is the abbreviations of the Bi-based superconductors which-is defined by the Bi₂Sr₂Ca_{n-1}Cu_nO_{2n+4+y} general composition, where n is the number of CuO₂ layers in the crystal structure. In this composition, the values of n are 1, 2 and 3. Regarding the values of n , Bi-based superconductors are characterized by three phases, named-called Bi-2201 phase, Bi-2212 phase and Bi-2223 phase with the critical amount-temperatures of 20, 85, and 110 K-critical-temperatures, respectively [11-13]. Smrckova *et al.* showed-indicated that the (Bi-2223) phase with the chemical formula of Bi₂Sr₂Ca₂Cu₃O_{10+y} is suitable for the-practical-use-to be used practically in superconducting devices with liquid nitrogen temperature ($T > 77$ K) [14]. In spite of many attempts and works to reach the Bi-2223 single phase, preparation-preparing of Bi-based superconducting system leads to the symbiosis of Bi-2223 and Bi-2212 and some-of-along with some-the impurity phases. On-In a BSCCO system, the superconductive characteristics, depend on the characteristics of the elements in the structure of the crystal. Researchers have found that Lead-lead (Pb) replacement improves the superconductive characteristics of the BSCCO system, -it-It means that Lead-lead is the most significant replacement element among the-other elements. The presence of Lead-lead (Pb) in the BSCCO system helps the reaction kinetics of Bi-2223 phase. The results of Pb-substitution-substituting Pb with Bi in preparing of BSCCO system with the formula of Bi_{2-x}Pb_xSr₂Ca₂Cu₃O₈ by the minimum amount of Pb (x), have indicated that $x = 0.3$ to $x = 0.4$. For this reason, a-lot-of-many researchers have selected Pb content (x) with an amount of 0.4 for preparing

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