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Influence of Sr(BO2)2 Doping on Superconducting Properties of (Bi,Pb)-2223 Phase

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Abstract : Chemical doping with different elements and compounds at various amounts represents the most suitable approach to improve the superconducting properties of bismuth-based superconductors for technological applications. In this paper, the influence of partial substitution of Sr(BO₂)₂ for SrO on the phase formation kinetics and transport properties of (Bi,Pb)-2223 HTS has been studied for the first time. Samples with nominal composition Bi_{1.7}Pb_{0.3}Sr_{2-x}Ca₂Cu₃O_y[Sr(BO₂)₂]_x, x=0, 0.0375, 0.075, 0.15, 0.25, were prepared by the standard solid state processing. The appropriate mixtures were calcined at 845 ^oC for 40 h. The resulting materials were pressed into pellets and annealed at 837 ^oC for 30 h in air. Superconducting properties of undoped (reference) and Sr(BO₂)₂-doped (Bi,Pb)-2223 compounds were investigated through X-ray diffraction (XRD), resistivity (ρ) and transport critical current density (J_c) measurements. The surface morphology changes in the prepared samples were examined by scanning electron microscope (SEM). XRD and J_c studies have shown that the low level Sr(BO₂)₂doping (x=0.0375-0.075) to the Sr-site promotes the formation of high-T_cphase and leads to the enhancement of current carrying capacity in (Bi,Pb)-2223 HTS. The doped sample with x=0.0375 has the best performance compared to other prepared samples. The estimated volume fraction of (Bi,Pb)-2223 phase increases from ~25 % for reference specimen to ~70 % for x=0.0375. Moreover, strong increase in the self-field J_c value was observed for this dopant amount (J_c=340 A/cm²), compared to an undoped sample (J_c=110 A/cm²). Pronounced enhancement of superconducting properties of (Bi,Pb)-2223 superconductor can be attributed to the acceleration of high-T_c phase formation as well as the improvement of inter-grain connectivity by small amounts of Sr(BO₂)₂ dopant.

Keywords : bismuth-based superconductor, critical current density, phase formation, $Sr(BO_2)_2$ doping
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