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Effect of Silver addition on the new $Y_3Ba_8Cu_{11}O_x$ Superconductors

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Abstract

The Y3-8-11 superconductors and silver composite superconductors were synthesized by solid state reaction. The standard four probes method was used to measure the critical temperature(T_c), and the XRD technique(FULLPROF PROGRAM) was used to determine the lattice parameters, space group and phase compositions. It was found that the pure Y3-8-11 has the lowest T_c onset about 95 K, and the more silver doped concentration, have the higher T_c offset and T_c onset. The samples have both superconducting phase and non-superconducting phase. The silver doped samples have higher superconducting phase. The Pmmm space group was corresponding as to superconducting phase. The non-superconducting phase exhibite in Y211 and $BaCuO_2$ with Pbnm and Im-3m, respectively. The surface of the silver doped sample is much smoother and denser compared to the undoped samples without impurities.

Introduction

In 2010, Udomsamuthirun et al [1] synthesized the new YBaCuO superconductors family. The Y3-8-11 superconductor shows sharp critical temperature curve. This property makes the Y3-8-11 to be potential candidate for a good superconductors. In 2009, Alibadi et al[2] synthesized Y358($Y_3Ba_5Cu_8O_{18}$) with high critical temperature at 102 K. In 1987, Chu and coworker[3] synthesized the $YB_2Cu_3O_7$(Y123) superconductor that shows the zero resistance at 93 K. These Y123 superconducting materials can be prepared in liquid nitrogen. The Y123 is very useful and can be widely applied such as high strong magnets that could be used for magnetic levitation for vehicles and energy storage system.

As many attempt to improve the synthesis conditions of Y123 superconducting powder and bulk samples, the synthesis method such as MTG(Melt Texture Growth)[4], MCP(Melt Condenser Processing) [5],, LPP(Liquid Phase Processing) [6], TSMG(Top Seed Melt Growth))[7], etc have been widely applied. Additionally, addition of AgO_2(silver oxide) to Y123 compound is also responsible for several improvements in the superconductors such as electrical, mechanical and structural properties[8]. It improves the strength and fracture toughness of samples and enhances the critical current density(J_c)[9], and reduces the normal state resistivity and improves the resistance.

In this work, silver powder as additive were used for improving in the preparation processes of $Y_3Ba_8Cu_{11}O_x$ superconducting bulk samples and its critical temperature. Besides, $Y_3Ba_{11}Cu_{18}O_x$ powders were used as materials for solid state reaction.

Materials and Methods

The $Y_3Ag_xBa_8Cu_{11}O_{7-\delta}$ compounds were synthesized by solid state reaction method using the followings high purity powdered chemicals, Y_2O_3, $BaCO_3$, CuO and AgO_2, with concentrations of silver oxide varied from 0, 0.1 and 0.2 mol. They were ground together in an agate mortar to help powders homogenous. The samples were calcined at 950^{o}C for 24 hours in box furnance and cooled to room temperature with cooling rate of 2.5^{o}C/min. The powders were reground and the above calcination process was repeated. The powders were then reground, pressed into pellet with diameters approximately 30 mm under 1,500 psi pressure and sintered at 950^{o}C for 24 hours and annealed at 500^{o}C for 12 hours. Then decreased the temperature to room temperature. The samples were characterized the critical temperature by the four-probes method measure the resistivity of