Effect of Grain Size on Oxygen Diffusion and Superconducting Properties of Top Seeded Melt Growth Processed YBCO Superconductors at Various Cooling Rates

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Superconducting transition temperature (T_c) and critical current density (J_c) of $YBa_2Cu_3O_{7-y}$ (Y123) superconductor is known to be greatly influenced by the oxygen content in an Y123 lattice. An oxygen deficient Y123 phase has a tetragonal crystal structure of non-superconducting, while an oxygen sufficient Y123 phase has a orthorhombic crystal structure of superconducting. Homogeneous oxygen embedding in an Y123 lattice is thus important in determining the property characteristics of an Y123 superconductor, because it determines T_c and J_c. In the case of samples prepared using powders by solid state reaction method, oxygen embedding is easy due to the presence of effective oxygen diffusion paths such as grain boundaries, while in the case of single crystal sample oxygen diffusion into the crystal is relatively difficult due to the absence of effective diffusion paths. To understand oxygen diffusion nature into the large Y123 bulk superconductors, Y123 samples with various grain boundary areas were fabricated by top-seeded melt growth process. The grain boundary area was controlled by varying the cooling rate from 1020℃ to 980℃. Phase formation and crystal structure were identified by powder X-ray diffraction and neutron diffraction. Microstructure of sample interiors was investigated by an optical microscope and scanning electron microscope. It was found that the crystal (grain) size of TSMG-processed Y123 samples decreased with an increasing cooling rate. The larger grain sample has less grain boundary area which can act as oxygen diffusion paths. Superconducting properties of TSMG-processed Y123 superconductors are reported in terms of oxygen content variation in parts of samples.

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