EFFECT OF Ca AND Sr DOPING OF $YBa_2Cu_3O_{7-\delta}$ HIGH T_C SUPERCONDUCTOR ON ITS CRITICAL PROPERTIES

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In polycrystalline superconductors, the poor flux pinning ability and the inter-grain weak links are the major limiting factors affecting the critical current and critical field which are very important for practical application of these superconductors. In this investigation it was attempted to enhance the flux pinning nature and the inter-grain connectivity of polycrystalline $YBa_2Cu_3O_{7-\delta}$ by the chemical doping. Yttrium (Y) and Barium (Ba) were partially replaced by Calcium (Ca) and Strontium (Sr) respectively. The samples were prepared by the conventional solid state reaction route. *X-ray* powder diffraction (XRD) studies revealed that all the samples were crystallized in the orthorhombic structure with space group *pmmm*. Detailed characterization was done by AC/DC magnetization, resistivity measurements under an applied DC field up to 13 Tesla by a Physical Properties Measurement System (*PPMS -Quantum Design-USA PPMS-14* Tesla).

DC magnetization measurements revealed that the pinning nature has been developed with the doping of both Ca and Sr in limited concentrations 15% and 10% respectively. The effect of the Ca and Sr doping on the inter-grain couplings was investigated through AC magnetization measurements and resistivity measurements under an applied DC field. It could be found that the enhanced grain couplings were induced due to the doping of Ca and Sr. Scanning Electron Microscopy (SEM) images also showed improved inter-grain connectivity.

The critical current densities were calculated using a method given in the Bean's model. In the Ca doped samples, the maximum global critical current density (J_C) was observed in the 5% doped sample. This sample showed an increase of more than 70% in the J_C than the pristine sample at 5 K. In the case of 10% of Sr doped sample a three fold increase in the inter–grain critical current density (J_C^{inter}) was observed around the critical temperature.

Upper critical field at absolute zero ($B_{C2}(0)$) was estimated by the Werthamer, Helfand, and Hohenberg (*WHH*) method. The $B_{C2}(0)$ values of doped samples were found to be increased approximately by two fold compared to that of un-doped sample. These enhancements in the critical current and critical field can be accounted in terms of having the maximum number of pinning centers and improved grain couplings of the doped samples.