EFFECT OF EXCESS Er_2O_3 ADDITION ON THE LEVITATION FORCE OF $ErBa_2Cu_3O_{7-\delta}$ SUPERCONDUCTOR

By

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ABSTRACT

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The effect of excess Er_2O_3 addition to superconducting $ErBa_2Cu_3O_{7-\delta}$ is reported. $ErBa_2Cu_3O_{7-\delta}$ pellets were prepared using conventional solid-state synthesis with final sintering at 930 °C in air for 24 hours. Appropriate amounts of Er_2O_3 (0 to 20 wt. %) was then added to $ErBa_2Cu_3O_{7-\delta}$ followed by regrinding and repelletizing before partial melting for a duration of 30 minutes in flowing oxygen at 1100 °C. The partially melted samples were reground and repelletized before final sintering at 930 °C in air for 24 hours. Resistance versus temperature measurements shows superconductivity only for samples with 0, 10 and 20 wt. % Er_2O_3 with $T_{c\ onset}$ between 89-92 K and $T_{c\ zero}$ between 71-84 K. Magnetic levitation force (MLF) measurements at 77 K on the samples observed non-linear relation between MLF with the amount of Er_2O_3 addition. At a separation distance of 0.24 cm between magnet and superconductor, MLF for pure sample is 9.9 mN. For the same separation distance, MLF initially drops to 1.8 mN for 5 wt. % Er_2O_3 and then increases back gradually from 4.9 mN for 10 wt. % Er_2O_3 to a maximum of 21.2 mN for 20 wt. % Er_2O_3. X-ray powder diffraction analyses showed formation of Er_2BaCuO_x (Er211) phase, which may act as flux pinning centers in the Er_2O_3-added samples. The experimental results were also discussed in relation to weight-loss analysis of the samples.

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CHAPTER 1

INTRODUCTION

Superconductivity is a fascinating and challenging field of physics. Scientist and engineers throughout the world have been striving to develop an understanding of this remarkable phenomenon for many years. Superconductors are materials that lose all their electrical resistivity below a certain temperature and so have the ability to conduct electricity without the loss of energy. This temperature is also known as the superconducting transition or critical temperature (T_c). Below T_c not only the resistivity of a material is exactly zero but it is also a perfect diamagnetic. T_c for conventional superconductors ranges from 0 to below 30K while for high temperature superconductors (HTSC) T_c ranges from 38K to above 100K.

Perfect diamagnetism in superconductors can be explained by the "Meissner effect" phenomenon. The Meissner effect cats to exclude magnetic fields from penetrating the interior of superconductors. Since the electrical resistance is zero, supercurrents are generated in the material to exclude the external magnetic field. The currents, which cancel the external field, produce magnetic poles that mirror the poles of the permanent magnet, repelling them to provide the lift to levitate the magnet. If a superconductor is cooled below T_c and a magnet is placed above it the magnet will began to float above the superconductor. The Meissner effect has become the basis of many industrial applications involving superconductors. Bulk samples can be automatically and stably levitated over (or suspended below) a magnet without any active control system. The stability of magnetic levitation of superconductors determines serviceability of many devices, such as magnetic