PREFACE

With many potential applications, study of high temperature superconductors (HTSC) is still a hot subject eluding proper understanding. Following the discovery of superconductivity in ceramic La-Ba-Cu-O system in 1986 by Bednorz and Muller, Copper Oxide family of superconductors has added new challenges and promises to this field. This family of superconductors includes Y-Ba-Cu-O (YBCO), Bi-Sr-Ca-Cu-O (BSCCO), Tl-Ba-Ca-Cu-0 (TBCCO) and Hg-Ba-Ca-Cu-0 (HBCCO) systems. Detailed investigations on these HTSC materials, involving modification of their compositions through doping or additions and also the process of synthesis, are essential to widen their technological applicability, overcoming the technical difficulties. Hence the scientific interests in high temperature superconductivity can be classified under two main categories via understanding the phenomena of superconductivity and optimization of superconducting properties for practical applications. Doping studies aid these goals in different ways. Primarily, doping into a parent compound may enhance or deteriorate the superconductivity of the parent compound thereby giving a clue to the origin of superconductivity in it. Secondly, doping may modify the field and temperature variations of physical properties to be more suitable for applications.

YBCO has proved to be of technological importance among the family of HTSC with its phase stability, chemical adaptability and high critical current density. Doping studies on the YBCO system without altering the parent structure can be done at V-site by Lanthanides, Ba-site by elements such as Lanthanum, Strontium, etc. and Cu-site by essentially 3-d elements. One of the established views is about the important role of Cu-O layer in the superconductivity of the high temperature ceramic cupric superconductors. In an orthorhombic YBa$_2$Cu$_3$O$_{7-\delta}$ crystal, while the CuO chain along the b-axis acts as a charge reservoir, the CuO$_2$ sheet in the ab plane acts as the conduction plane for the superconducting electrons. It is this fact that makes studies on doping at Cu site important for the understanding of superconductivity in these cuprates. Fe and Co are known to occupy Cu(I) site along the b-axis, whereas Ni and Zn are known to take Cu(II) site in the ab plane. Of these dopants Zn had been found to decrease $T_c$ drastically at a rate of almost 10 K/at.% doping. Unlike in the conventional superconductors, magnetic pair breaking caused by the magnetic impurity is known to have least effect on HTSC but the local disorder introduced by the substituents in the CuO$_2$ plane can kill the superconductivity even at low doping levels, as in the case of Zn. Due to low solubility
limit a detailed study on the effect of Mn at Cu site is scarcely found in the literature. Mn with its higher magnetic moment is known to occupy Cu(l) site from the neutron diffraction experiments. But $T_c$ remains least altered, indicating the magnetic pair breaking to be insignificant in this system. Hence this system with doping of Mn having high magnetic moment was taken up for detailed study.

Organization of the Thesis is as follows:

The first chapter introduces the field of superconductivity and presents a detailed account of the effect of various substituents on the properties of YBCO, as is known from literature.

The second chapter deals with the details of sample preparation and their characterization through XRD, temperature variation of resistivity and susceptibility. The experimental details of the characterization techniques are also discussed.

The third chapter on the transport study explains the temperature variation of resistivity and the Seebeck coefficient measurements. From the temperature variation of resistivity, the effect of dopant concentration on the transition temperature and width and the normal state resistivity are discussed. The normal state Seebeck coefficient data is analyzed in terms of various models such as metallic diffusion model, Nagaosa Lee model and Gasumyants narrow band model and the parameters obtained are discussed.

The fourth chapter begins with the details of the theoretical modeling, which is used in analyzing the magnetic properties. This chapter further can be grouped into three sections namely (a) the temperature and field variation of ac susceptibility, (b) DC SQUID magnetization measurements and (c)ac MH loops. The magnetic parameters such as $H_{c1}$, $J_c$, $H_c^*$, flux profile $(\rho/R)$ and losses respectively for the grain and intergranular region derived from various measurements are discussed and correlated. The intergranular properties show a strong influence of microstructural features that shadow the variation with Mn content. The grain properties vary systematically with dopant concentration. This could be because the nature of the intergranular regions is highly process dependent.

Finally, the fifth chapter summarizes the results and the puts forth the conclusions made from the various studies presented in this thesis.