

Abstract

It is generally believed that one of the key parameters controlling the normal state and superconducting properties is the charge carrier concentration in the CuO_2 planes, p . By changing the non-isovalent doping concentration on the RE site as well as the oxygen content in $(\text{RE})\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$, an excellent tool is obtained to vary the hole concentration over a wide range from the underdoped up to the overdoped regime. In the present thesis the focus is on the doping effects on the structural and normal state electrical properties in doped Nd-123 with Ca, La, Pr, Ca-Pr, and Ca-Th. The effects of doping have been investigated on structural properties, superconducting critical temperature, and on the hole concentration by X-ray and neutron powder diffraction, resistivity, thermoelectric power S , and Hall coefficient R_H measurements. Some important results are following:

(i) *The valence of Pr in the RE-123 family.* Results from the structural investigations, the critical temperature T_c , and the thermoelectric power indicated a valence +4 at low doping concentration, which is in agreement with results of charge neutral doping in the RE-123 family.

(ii) *Hole localization.* The results of bond valence sums (BVS) calculation from the neutron diffraction data shown that hole localization on the Pr^{+4} site was the main reason for the decrease of the hole concentration in the CuO_2 planes. Different type of localization was inferred by S measurements for Ca-Th and Ca-Pr dopings.

(iii) *Competition between added charge and disorder.* The results of R_H measurements indicated that Ca doping introduced disorder in the CuO_2 planes in addition to added charge. This could be the main reason for the observed small decrease of the bandwidth of the density of states on the base of the phenomenological narrow band model.

(iv) *Empirical parabolic relation between γ vs. p .* S data were well analysed in a two-band model with an additional linear T term, γT . An empirical parabolic relation for γ as a function of hole concentration has been found.

(v) *Entered La on the Ba site.* Hole concentration p in the CuO_2 planes were estimated from room temperature thermoelectric power in $\text{Nd}_{1-x}\text{La}_x\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$. From linear relation between p and La doping concentration, it was inferred that 26 % of the La atoms went to Ba sites.

Key words: high temperature superconductors, critical temperature, resistivity, thermoelectric power, Hall coefficient, X-ray diffraction, Neutron diffraction, $\text{NdBa}_2\text{Cu}_3\text{O}_{7-\delta}$, hole concentration, substitution.