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Pr-123, superconductor or not?

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Abstract - The existence or not of superconductivity in $PrBa_2Cu_3O_{7-\delta}$ (Pr-123) is still a polemic subject and a remarkable open question. It is known that partial substitution of Y for Pr on $Pr_xY_{1-x}Ba_2Cu_3O_{7-\delta}$ in samples prepared by usual methods quenches the superconductivity for a value of x of about 0.5. The causes of this suppression are not understood yet. This work presents a systematic study on the influence of synthesis conditions in the superconductor properties of polycrystalline $Pr_xY_{1-x}Ba_2Cu_3O_{7-\delta}$. Remarkably, we found that in certain growing conditions all members of the PrY-123 are superconductor including pure Pr-123.

Generally, the substitution of rare earth elements on the Y site does not show important effects on the magnetic and superconducting properties. One exception to this behavior is the substitution of Y for Pr. Some authors have reported that its partial substitution in a compound of the form $Pr_xY_{1-x}Ba_2Cu_3O_{7-\delta}$ (PrY-123) quenches the superconductivity for a certain value of x. However, the mechanism responsible for this suppression is not understood yet. Also, there exists a great controversy respect of the mechanisms responsible for this behavior. However, in the last decade, superconductivity in Pr-123 samples has been reported for some authors where the method of syntheses appears to be responsible for the formation of the superconducting phase [1,2]. A definitive result about superconductivity or not in this compound is important because many models about Pr no PrY-123 and related with high temperature superconductivity have been proposed depending on this.

This work presents a systematic study on the influence of synthesis conditions in the superconducting properties of polycrystalline PrY-123. Bulk polycrystalline samples were prepared by following a chemical route based in a modified polymeric precursor method. This method is recognized to produce very homogeneous samples reducing the presence of secondary phases, in comparison with the traditional method of solid-state reaction [3]. The influence of the gas atmosphere used during both calcinations and sinterization (Oxygen or Argon) was studied.

AC and DC magnetic susceptibility measurements show that the superconducting transition temperature increase in samples prepared in argon respect to the samples prepared in oxygen (for the same Pr composition), when Pr concentration is less than 0.5 (Figure 1). For all samples synthesized under Argon flux, including pure Pr-123, AC and DC susceptibility curves show a superconductor transition (Figure 2) in temperatures between 50 and 95 K (depending on the Pr content). In summary, we conclude that when prepared on the certain conditions the Pr-123 is superconductor, as all the others Re-123 (Re=rare earth).

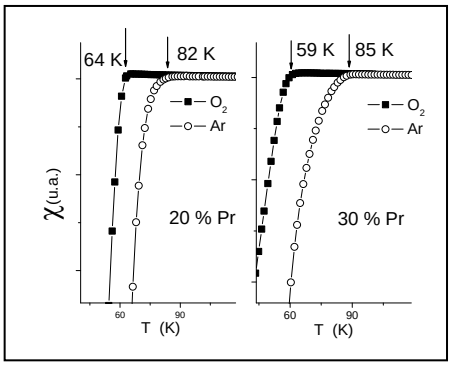

Figure 1: χ_{DC} (T) for $Pr_xY_{1-x}Ba_2Cu_3O_{7-\delta}$ (x=0.1, 0.3) samples prepared under O_2 or Ar flux (H_{DC}= 200 Oe).

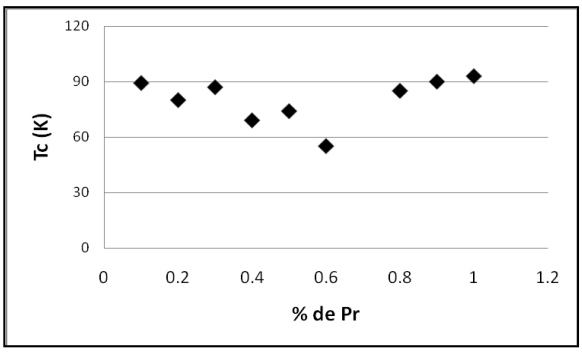

Figure 2: Tc vs. Pr content for $Pr_xY_{1x}Ba_2Cu_3O_{7-\delta}$ samples synthesized on Ar flux

References

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