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In Search for Recrystalization of (Bi,PB)-22223 Phase after its Complete Melting

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Abstract – This paper presents a search for a thermal profile in air that promotes recrystalization of the highest T_c (110 K) phase of Bi-Sr-Ca-Cu-O system, "(Bi.Pb)-2223", after its complete melting, as well the effects of PbO and metallic Ag as additives. The samples of (Bi,Pb)-2223 were prepared by solid-state reaction in a sequence of five thermal treatments with intermediate grounding in air. The powder obtained after those thermal treatments was characterized by AC susceptibility measurements, x-ray diffraction, Rietveld Analysis and simultaneous DTA/TGA. Variable amounts of PbO and Ag were used as additives mixed with (Bi,Pb)-2223 powder. The best thermal profile to promote recrystallization of (Bi,Pb)-2223 after its complete melting without additives was determined in controlled air atmosphere. The solidified products with additives were obtained using the same basic thermal profile in controlled air atmosphere. Products with those additives were characterized by AC magnetic susceptibility measurements, x-ray diffraction, Rietveld Analysis and SEM with EDS. The results allow a control of non-superconducting phases fractions that may be used for vortex pinning.

The phase with T_c=110K in the Bi-Sr-Ca-Cu-O system ("BSCCO") has the nominal composition "$Bi_2Sr_2Ca_2Cu_3O_{10}$" and is known as "Bi-2223". To obtain such a phase as a single one in samples is a challenge for materials science. Partial substitution of Bi for Pb leads to a major amount of the that "(Bi,Pb)-2223" phase in samples. The use of partial decomposition leads to higher recrystallized amounts of the (Bi,Pb)-2223 phase and it is a challenge to promote recrystallization of the (Bi,Pb)-2223 phase after its complete melting. (Bi,Pb)-2223 melts completely at temperatures that depend on Pb content, presence and amount of Ag, atmosphere, among other experimental conditions.. Melting of (Bi,Pb)-2223 is accompanied by structural Pb evaporation, which may reduce the amount of (Bi,Pb)-2223 solidified. Ag reduces the peritetic decomposition temperature do not oxide in air at high temperature process, improves intergranular critical current, do not react with solid superconducting BSCCO phases and do not alter stoichiometry. With the knowledge of an optimal thermal profile to completely melt (Bi,Pb)-2223 and recrystallize it, one may ask if Ag and/or if PbO addition would be able to compensate that Pb loss in melting and improve (B,Pb)-2223 recrystallization from the melt. Using a "precursor powder" with 92%wt of (Bi,Pb)-2223 (T_c=105 K) we determined an optimal thermal profile to achieve total melting of that phase with high (%wt) recrystallization. We studied thermal profiles that used heating at 5°C/min up to 870-890°C followed by isothermal heat treatment for 100-200 min (for complete melting), cooling at 0.1°C/min to 825°C (for recrystallization) and after that the sample was quenched to room temperature. The characterization techniques were AC susceptibility measurements, x-ray diffraction, Rietveld Analysis, simultaneous DTA/TGA and SEM with EDS. Without PbO and Ag as additives, the three superconducting phases of the BSCCO system were obtained: 95%wt of (Bi,Pb)-2223, 4.4%wt of the $Bi_2Sr_2CuO_z$ phase ("Bi-2201") and 0.6%wt of $Bi_2Sr_2CaCu_2O_y$ phase ("Bi-2212"). The use of PbO and/or Ag with different concentrations, each one alone or both mixed, with that same optimal thermal profile reveled the formation of other superconducting as well non-superconducting phases whose amount depends on the concentration of those additives (Figures 1 and 2). Among the results obtained we may point that we are able to control the amount of non-superconducting phases and with that to promote the formation of pinning centers.

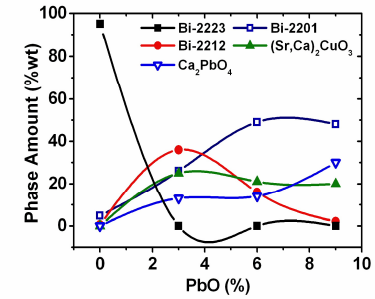

Figure 1: Phases amount dependence on PbO content as additive

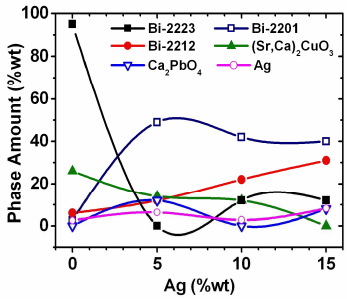

Figure 2: Phases amount dependence on Ag as additive.

References

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