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STABILIZATION OF HIGH T_c PHASE IN BISMUTH
CUPRATE SUPERCONDUCTOR BY LEAD DOPING

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ABSTRACT

It has widely been ascertained that doping of lead in Bi:Sr:Ca:Cu:O systems promotes the growth of high T_c (110 K) phase, improves critical current density, and lowers processing temperature. A systematic investigation is undertaken in the present study to determine optimum lead content and processing conditions to achieve these.

A large number of samples with cationic compositions of $\text{Bi}_{2-x}\text{Pb}_x\text{Sr}_2\text{Ca}_2\text{Cu}_3$ ($x=0.2$ to 2.0) were prepared by conventional solid-state reaction technique. Samples of all compositions were annealed together at a temperature and characterized through resistance-temperature (R-T) measurements and X-ray diffraction (XRD) to determine the zero resistance temperature, $T_c(0)$ and to identify presence of phases, respectively. The annealing temperature was varied between 790°C and 880°C to optimize processing parameters.

For x value between 0.3 to 0.8 , $T_c(0)$ above 110 K is obtained when the samples were annealed at a temperature in the range of 855°C to 870°C for 40 hours. The best samples showed $T_c(0)=113$ K and critical current density of about $200\text{A}/\text{cm}^2$. An optimum process yielded a large volume fraction of high T_c phase as determined from intensity peaks in XRD spectra. These results were supported through magnetic susceptibility measurements on samples having high $T_c(0)$ values. The samples showed no change in R-T characteristics on repeated thermal cycling between 77 K and 300 K, even after a few weeks of their preparation.

In brief, we report an optimum process and composition of leaded bismuth cuprate superconductor which yields nearly a high T_c single phase with highly stable superconducting properties.