SUPERCONDUCTIVITY OF Y\textsubscript{1-x}Ba\textsubscript{x}Sr\textsubscript{x}Cu\textsubscript{3}O\textsubscript{y} SYSTEM


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Tc depressed with increasing Sr substitution in YBa\textsubscript{2-x}Sr\textsubscript{x}Cu\textsubscript{3}O\textsubscript{y} system. However x-ray diffraction revealed monophase similar to the basic 1-2-3 structure persists for X up to 1.0. Extensive dislocation was observed for X=1 which seems associated with local variation of Sr/Ba atomic ratio and arrangement.

1. INTRODUCTION

Tc enhancement had been reported in a Y-Ba-Sr-Cu-O system (1), however subsequent studies had shown systematic depression of Tc with increasing Sr content for the compounds of YBa\textsubscript{2-x}Sr\textsubscript{x}Cu\textsubscript{3}O\textsubscript{y} (2-5). These investigations concentrated almost exclusively on the crystal structure and superconducting properties. In this paper the effects of composition on the superconductivity and the microstructure of the YBa\textsubscript{2-x}Sr\textsubscript{x}Cu\textsubscript{3}O\textsubscript{y} system with emphasis on x=1 and dislocation structure are reported.

2. EXPERIMENTAL PROCEDURES

The YBa\textsubscript{2-x}Sr\textsubscript{x}Cu\textsubscript{3}O\textsubscript{y} compounds were prepared with the corresponding reagent grade metal nitrates in stoichiometric proportion by the gel route (6). Powders were calcined at 950°C then sintered at 950°C for 16 h in flowing O2. Electrical resistance was measured by standard four point probe technique in a closed cycle refrigerator. Phase identification was obtained by means of a conventional X-ray diffractometer (XRD) with Cu-Kα radiation. Transmission electron microscopy (TEM) and scanning electron microscopy (SEM) were applied to characterize the microstructure. In order to avoid the selective etching and ion bombardment effects, samples for electron microscope examinations were generally prepared from sintered compacts, or from the as-synthesized powder, by grinding in a pestle and mortar. However, some samples were also prepared by mechanically grinding the samples to about 50 μm in thickness followed by ion milling to electron transparency. A JEOL-2000 FX transmission electron microscope operating at 200 KV was used.

3. RESULTS AND DISCUSSION

The effect of x on the superconductivity is shown in Fig. 1. Sr substitution lowers the superconductive characteristics of the YBa\textsubscript{2-x}Sr\textsubscript{x}Cu\textsubscript{3}O\textsubscript{y} system as previously found. XRD revealed that only the x=0 to 1 compounds were monophasic all the others being of mixed phases (Fig. 2). Interestingly, the XRD structure for the x=0.5 and 1 samples is that of the typical 1-2-3 perovskite, except the cell volume for the x=1 sample is relatively contracted with a = 0.3794 nm, b = 0.3858 nm,
and $c = 1.155$ nm. These are similar as found in (I).

Twins were found to be present in all the samples. Twins lie on (110) and (110) planes, but exchange the [100] and [010] directions. In contrast to twin structure, dislocations were observed only in calcined and sintered samples for stoichiometry of $x=1$. The dislocations were predominantly screw in character with $1/2[100]$ or $1/2[010]$ Burgers vectors. Examples are shown in Fig. 3. Lattice images of a 90° boundary, which is defined to be a boundary of two neighboring grains with [100] or [010] direction of one grain parallel to [001] direction of the other grain, also confirmed that the dislocations are of [100] or [010] type Burgers vector. Figs. 4A-B show a high resolution lattice image of such a boundary and accompanying diffraction pattern, respectively.

In the $x=1$ samples, EDS measurements of TEM specimens revealed local variation in atomic percentages of Ba and Sr atoms near dislocations. Whereas in areas away from dislocations the Ba/Sr ratio was similar and close to unity. Possible ramifications of the presence of dislocations and local variation of Ba/Sr atomic concentrations near dislocations on superconducting properties in Y-Ba-Sr-Cu-O system are being pursued. Specially since dislocations are known to act as effective flux pinning agents.

4. CONCLUSIONS

$T_c$ degrades with Sr substitution in Y$_{2-x}$Sr$_x$Cu$_3$O$_y$ system. The presence of non-superconducting phases is mainly responsible for such $T_c$ depression. However single phase material occurs for $x$ up to 1 with structure similar to that of Y$_{2}$Cu$_3$O$_y$. Extensive dislocation was observed for $x=1$ which seems associated with local variation of Sr/Ba atomic ratio and arrangement.

REFERENCE