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Fabrication and Microstructure of Hg-1223 Tape

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A two-step spray/press process for the fabrication of Hg-1223 tape on a flexible Ni-substrate coated with Cr/(Ag,Pd) has been developed by using the mechanically aligned c-axis oriented Hg-1212 micrograins as the nucleation sites for the large c-axis oriented Hg-1223 grain growth. The self-field J_c of Hg-1223 tapes so reproducibly obtained is $7x10^4$ A/cm^2 at 77 K.

$HgBa_2Ca_2Cu_3O_x$ (Hg-1223) has been extensively studied because of its high superconducting transition temperature (T_c = 135 K [1] at ambient pressure) and its moderate magnetic flux pinning force which lies between those of YBCO and BSCCO [2]. These factors combine to make Hg-1223 an attractive candidate for use in commercial applications. However, chemical instability and complexity in preparation of Hg-1223 is a bottle neck. Different measures have been taken to improve the chemical stability of the compound [3], such as the addition of small amount of ReO_2 which acts as a stabilizer and enables the handing of these oxide powder in air without inhibiting the formation of Hg-1223 [4]. Furthermore, the addition of HgX_2 (X = Cl, I, F) reduces the formation time and promotes the grain growth of Hg-1223. With this progress, we have been successful in fabricating highly c-oriented Hg-1223 thick films on a flexible Ni tape with a thin Cr/Ag buffer layer between them to achieve a $J_c \sim 2.5x10^4$ A/cm^2 at 77 K by using the controlled vapor/solid reaction technique [5].

Unfortunately, the reproducibility is poor and the J_c is still too low to be commercially viable. We have, therefore, carried out a systematic investigation on the grain formation, grain alignment, and densification of Hg-1223 on a Ni-substrate coated with thin Cr/(Ag,Pd) buffer layer. Effect of the Ni-substrate on the phase formation and physical properties of Hg-1223 tape. We found that large Hg-1223 grains can grow from small Hg-1212 grains embedded in oxides of Ca and Cu. A two step spray/press process has therefore been successfully developed to prepare reproducibly Hg-1223/Ni tapes with a $J_c \sim 7x10^4$ A/cm^2, more than twice that obtained by the previous single step spray/press technique, by improving the density of Hg-1223 via Hg-1212 growth from mechanically aligned small Hg-1212 grains functioning as nucleation center. The solubility limit of Ni in Hg-1223 is less than 0.1 at%. By using the proper sintering temperature. Ni can be completely eliminated.

Fig. 1 display the microstructure of Hg-1223 tape obtained via the two step spray/press process.

To show that the improved grain alignment and sample density higher J_c, we have measured the dc current-can lead to voltage characteristics of the samples with a pulsed-current source. The results are displayed in Figure 2. After the second press/heat-treatment, sample A has a $J_c \sim 7x10^4$ A/cm^2 at 77 K in its self-field with a 50 μV/cm resolution more than two times that

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obtained by the previous one-step spray/press process [5].

Fig. 1 The microstructure of Hg-1223 tape

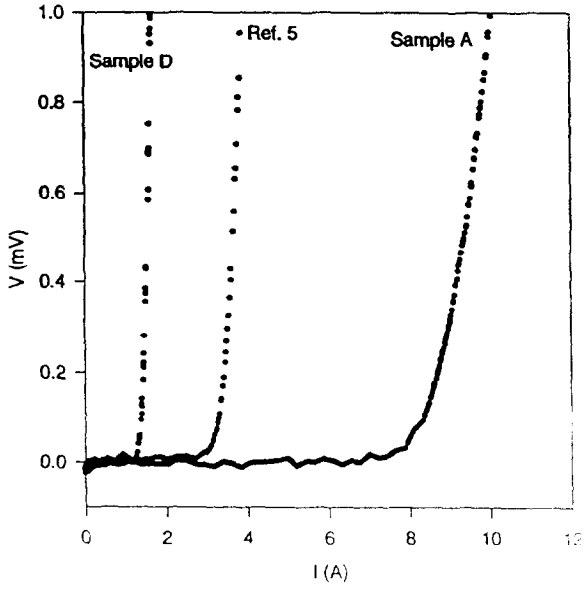

Fig. 2 The current-voltage characteristics of samples A and D after the second press/heat-treatment.

The low J_c of sample D is a result of cracks made in the Hg-1212 and Hg-1223 grains caused by the second pressing. The final heat-treatment was unable to heal these cracks. Because the weak-links still exist the magnetic field effect on the T_c of these samples will be measured later on better connected samples. Fig. 3 shows the dependency of the Ni-content in Hg-1223 grains of tapes on the synthesis temperature. The results leading us to conclude that Ni is a promising substrate.

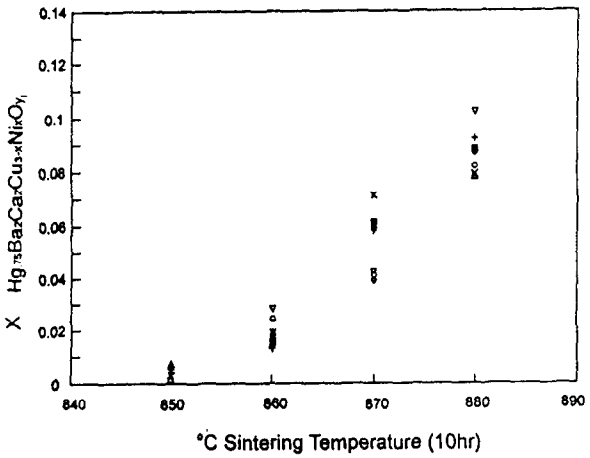

Fig. 3 The dependency of the Ni-content in Hg-1223 grains of tapes.

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