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YBCO/Ag PIT-TAPES PREPARED WITH NANOSIZED POWDER

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YBCO single-filament powder-in-tube tapes were prepared using nanosized YBCO powder and annealing the tapes in N_2/O_2 atmosphere. This resulted in high critical current, I_c, tapes, with *ab*- and *c*-texturing at the interface between the silver sheath and the superconductor.

The YBCO nanopowder was prepared using the citrate-gel method[1, 2], where the nitrates of the metals are mixed together and citric acid is added. The gel is then dried and calcined at 500^{o}C and the resulting powder is lightly ground. The powder is annealed in O_2 at 790^{o}C resulting in X-phase YBCO. The conversion to fully oxygenized orthorhombic YBCO is done by annealing in Ar at 790^{o}C and cooling in O_2. Annealing in Ar is repeated three times. This results in 1-3 nm thick and 50-100 nm wide particles with T_c = 92 K.

The tapes were prepared using the standard PIT-method.[3, 4] After drawing and rolling the tape was 2.2 mm wide and 200 μm thick with filling factor of 35 %. 4 cm long pieces of the tape were annealed in N_2 at 900 - 950^{o}C for ten to twenty hours and cooled in O_2 with the cooling rate of 50 - 150^{o}C/h to 650^{o}C where the samples were kept for four hours. The cooling continued with the rate of 150^{o}C/h to 440^{o}C, where the temperature was dwelled for eight hours before cooling to room temperature with the rate of 50^{o}C/h. The I_c was subsequently measured in liquid N_2 and self-field using the 1 μV/cm criterion. The highest I_c = 5.02 A, which corresponds to critical current density of 3300 A/cm^2, was obtained by annealing at 946^{o}C for 10 h and cooling with 150^{o}C/h. The magnetic measurements show that the tapes have critical temperature of 89 K and that the hysteresis loop is still open at 1 T, which suggests that the tapes perform better in magnetic field than the commercial BSCCO-tapes.

The texture of the tapes[5] was studied using XRD with a texture goniometer. First the silver sheath was removed either by dissolving it into mercury or with a knife. Dissolving does not affect the superconductor and exposes essentially the interface surface of the superconductor. Removing the silver with a knife on the other hand opens the tape nearer to the middle of the tape, which enables measurements at two different positions of the tape. The pole figures of (103) peaks were measured with $\Delta\phi = 5^o$ and $\Delta\psi = 5^o$. It was found that the texture clearly correlates with the observed I_c. The best tape had (Fig. 1a) two-fold symmetry distinctive of texturing in *ab*- and *c*-directions, whereas a tape with lower I_c = 1 A (Fig. 1b) had a ring type symmetry indicating *c*-axis texturing only. When the best tape was opened with a knife, it still showed 2-fold symmetry, but not so pronounced as in the Hg opened tape, indicating that the best texture is found at the interface between the silver and the superconductor, as has also been found for BSCCO tapes.[6]

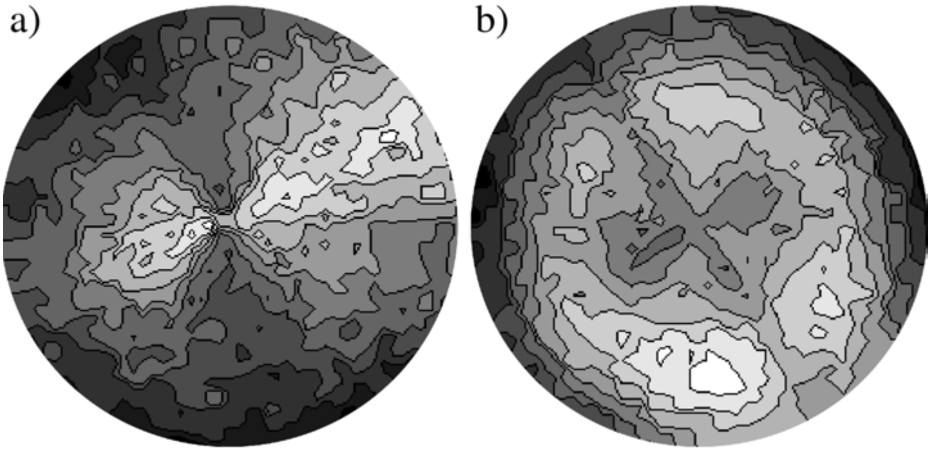

Fig. 1. Pole figures of (a) the best $I_c = 5.02$ A tape and (b) a $I_c = 1.0$ A tape. The best tape has a clear two-fold symmetry indicating *ab*-texturing, whereas the other tape exhibits ring-type symmetry and *c*-axis texturing only.

In conclusion we can say that using the nano-powder for manufacturing YBCO PIT-tapes has so far shown the largest I_c published and also to our knowledge the only evidence of *ab*-texturing in the superconductor. Since texturing is better at the silver-superconductor interface, the next logical step in the development of YBCO-tapes is multifilament tapes, where the interface area is maximized.

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