§15. Effect of Silver Wire Addition to BPSCCO Superconductor Bulk

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High Tc Superconductors such as BPSCCO and YBCO are candidate materials for current leads and superconducting joints between super fluid helium and normal liquid helium, because of the high current capacity and the low thermal conductivity. The high Tc superconductors are one kind of ceramics, so it is very brittle and it is hard to change the mechanical properties without combining with reinforcement materials. In this study, silver wire was used as a reinforcement of BPSCCO and investigations of the effect of the silver reinforcement wire on the mechanical properties at room temperature and on the critical current at 77 K were performed. Regarding the ceramics fiber addition, the data are presented in Reference 1 and 2.

BPSCCO powder, of which size is less than 10 μm, was used for a matrix, and silver wire of 0.2 mm diameter and 40 mm long was applied as a reinforcement material. The silver wires were arranged uni-directionally in the matrix of BPSCCO powder. The plate size was 40 mm^W x 50 mm^L x 7 mm^T, and the wires were disposed in the direction of 40 mm. The plates were pressed mechanically up to 90 MPa and additional compression of 294 MPa was applied to some of them by a cold isostatic press (CIP). After the compression, the plate was heat-treated at 1113 K - 1118 K for 180 ks. As a reference, a bulk BPSCCO plate without Ag wires was prepared on the same process. 3-point bend bars of 4 mm^W x 40 mm^L x 5 mm^T were machined out and 3-point bending tests were carried out at room temperature to investigate the bending strength. The critical current density was measured at 77 K by four-probes method.

The vertical cross section to the silver wire of the plate was observed by SEM to investigate the interface of silver wire and the matrix. The coherence of silver wire and the matrix was considerably better than the case of ceramics fiber in BPSCCO matrix [2]. It seems to come from good deformation ability of silver wire.

The bending strength against the weight ratio of silver wire is shown in Fig.2. By arranging silver wires in the matrix, the bending strength becomes higher with an increase of the weight ratio of silver wire. In addition, the additional CIP treatment at 294 MPa increases the bending strength. This fact shows that high density of the matrix gives high strength. Although the no-Ag BPSCCO sample broke into two pieces perfectly during the test, the sample reinforced by silver wires was not separated after the bending test. Moreover, the broken sample reinforced by silver wires still showed the superconductivity at 77 K. From these results, it is clear that silver wires reinforce the BPSCCO bulk by the good coherence with the matrix and resist the crack propagation.

The result of the critical current density measurement is shown in Fig. 2. The critical current increases according to the increment of the weight ratio of silver wire. It is reported [3] that large flake-like structure forms on the silver sheet in BPSCCO matrix and it can carry much current at 77 K. Taking this fact into account, the same structure will appear on the silver wire surface and it will carry the higher current, resulting in giving the high critical density.

From these results, it is concluded that the bending strength and the critical current density can be improved by arranging the silver wire in BPSCCO matrix.

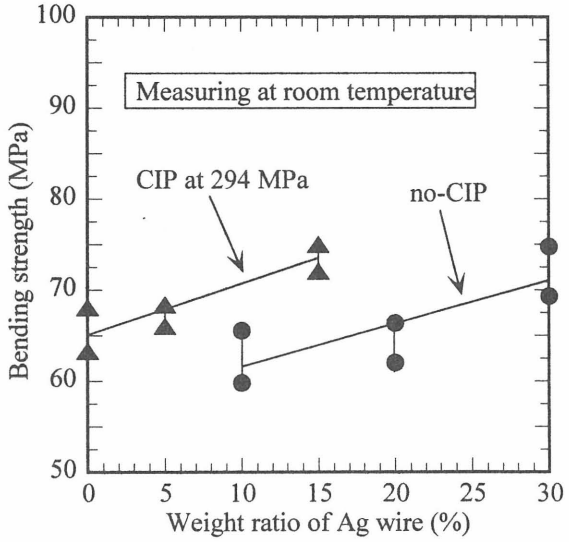

Fig. 1 Bending strength of the Ag-wire/BPSCCO samples and the no-fiber BPSCCO at room temperature.

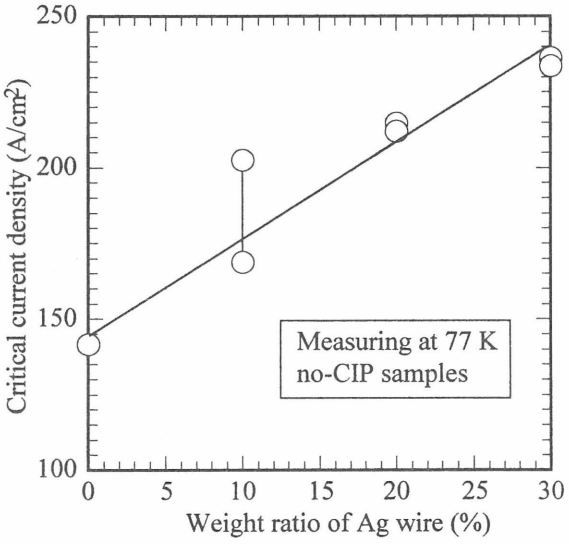

Fig. 2 Critical current density of the Ag-wire/BPSCCO samples and the no-fiber BPSCCO at 77 K.

Reference
[1] Matsunaga, K., et al., Adv. in Superconductivity X, Springer-Verlag, Tokyo (1998) 861.
[2] Matsunaga, K, et al., Cryogenic Engineering, **34**, (1999) 722. (in Japanese)
[3] Nemoto, S., et al., 60th Meeting on Cryogenics and Superconductivity, (1999) E1-19.