## §14. High Performance A15 Compound Superconductors Prepared Through a New Route

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New $Nb_3Sn$ superconductors with excellent high-field performance have been fabricated using Ta-Sn powder core and Nb or Nb-Ta alloy sheath. The Ta-Sn powder was easily synthesized by the melt diffusion reaction between Ta and Sn powders. The mixed powder of Ta and Sn was reacted at 950°C for 10h in an alumina crucible in vacuum, the atomic ratio of Ta and Sn in the mixed powder being 6:5. The resulting Ta-Sn powder was encased in a Nb, Nb-1.8at%Ta, Nb-3.3at%Ta or Nb-4.2at%Ta tube, and then fabricated into a tape of 5mm-wide and 0.5mm-thick. The specimens were heat-treated at temperatures between 750°C and 950°C in vacuum for the diffusion reaction to form a $Nb_3Sn$ layer between the sheath and the core.

Fig.1 is the EPMA composition mapping of Nb taken on the cross-section of the tape specimen with Nb sheath reacted at 925°C for 80h. A thick and uniform $Nb_3Sn$ layer, about 80μm in thickness, is formed as illustrated in Fig.1. The thickness of the $Nb_3Sn$ layer formed in the specimen with Nb-Ta sheath is the same as that formed in the specimen with Nb sheath. Sn seems to have much stronger affinity against Nb than against Ta, which results the enhancement of the diffusion of Sn from the Ta-Sn core to the Nb sheath. It is noticeable that Nb is incorporated into the core from the sheath passing through the $Nb_3Sn$ layer. No void is formed in the core after the reaction, since Sn in the core and Nb in the sheath inter-diffuse each other. In the specimens with small amount of Cu addition to the Ta-Sn core, a thick and uniform $Nb_3Sn$ layer is obtained after the reaction at 800°C for 80h.Ta diffuses into the $Nb_3Sn$ layer from both the Ta-Sn core and the Nb-Ta sheath.

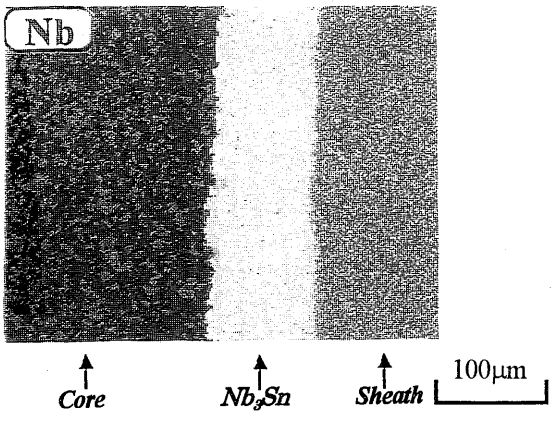


Fig.1 EPMA composition mapping of Nb on the cross-section of the Ta-Sn/Nb tape specimen reacted at 925°C for 80h.

Transition temperature $T_c$ and critical current $I_c$ at 4.2K of specimens were measured by a four-probe resistive method, the criterion of $I_c$ measurement being 1μV/cm. The magnetic field was applied perpendicular to the specimen current and parallel to the specimen surface at the time of $I_c$ measurement. $T_c$ of the specimen reaches a maximum value after the reaction at 900°C. The specimen with Nb-3.3at%Ta sheath shows a $T_c$ of 18.4K which is apparently higher than that of the specimen with Nb sheath. The addition of 2-5wt%Cu to the core decreases the optimum reaction temperature to 800°C.

Fig.2 is the $I_c$ versus magnetic field curves of tape specimens with Nb and Nb-Ta alloy sheath. The increase of Ta concentration in the sheath yields the enhancement of $I_c$ in high fields. This may be attributed to the increase of the Ta concentration in the $Nb_3Sn$ layer. A $I_c$ of ~200A has been obtained at 23T and 4.2K in the specimen with Nb-4.2at%Ta sheath, the overall critical current density of the tape being $\sim 8 \times 10^3 A/cm^2$. The present new process is quite simple, and no intermediate annealing is required for the fabrication. The fabrication of multifilamentary wires with stabilizing Cu through the present process seems to be straightforward.

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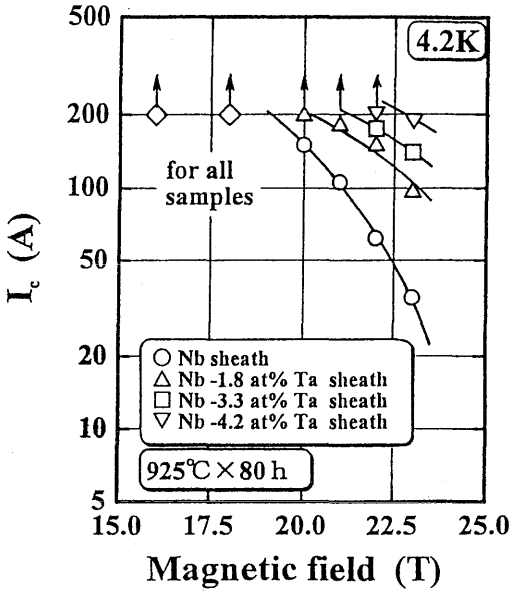


Fig.2 $I_c$ versus magnetic field curves for tape specimens with Nb and Nb-Ta alloy sheath heat treated at 925°C for 80h.

Reference

1) Tachikawa, K., et al., New High-field $Nb_3Sn$ Superconductors Prepared from Intermediate Compound Powders, Proc. ICEC17, IOP (1998) 403.
2) Tachikawa, K. et al., New High-field $Nb_3Sn$ Conductors Prepared from Ta-Sn Compound Powders, to be Published in IEEE Trans.Appl.Supercond., vol 9 (1999).