§26. Investigation of the Cross-sectional Configuration of Ag Sheath Material for High Strength Bi-2212 Superconducting Wire

Yamada, Y. (Tokai Univ.),
Hishinuma, Y.

The key issues of the superconducting wire in the advanced fusion reactor beyond ITER are J_c improvement under the high magnetic field and higher mechanical strength for the large electromagnetic force. On the other hands, it is known that Y and Bi system high T_c oxide superconducting wires have higher J_c property under the high magnetic field above 20T compared with A15 compound superconducting wire as Nb_3Sn and Nb_3Al.

Especially, $Bi_2Sr_2CaCu_2O_x$ (Bi-2212) oxide superconducting wire is easy to make round-shape wire, so that Bi-2212 wire is easy to apply for the large Cable-in Condit (CIC) conductor of the fusion reactor. However, mechanical strength of the Bi-2212/Ag wire is remarkably lower than A15 compound superconducting wire because Bi-2212 compound is brittle material as a consequence of ceramic. In addition, the sheath material of the Bi-2212 superconducting wire is used only Ag and/or Ag based alloy in order to show the high J_c performance.

In this study, we carried out investigation of the wire configuration of the Bi-2212 round wire to realize higher mechanical strength for the large electromagnetic force without decreasing of J_c performance.

In order to improve mechanical strength of Bi-2212/Ag round wire, it is well used the Ag-Cu and/or Ag-Mg alloy as sheath materials on the Bi-2212 round shape wire. Bi-2212/Ag round wire was heat-treated by the "partial melting-slow cooling process" because of the forming of highly c-axis oriented and dense microstructure. In the case of the investigation of the mechanical strength improvement in Bi-2212/Ag round wire by the composite of the high mechanical strength metal, this composite metal is required to higher melting point compared with Bi-2212 compound. We approached the higher mechanical strength of the Bi-2212/Ag round wire by the composite of the metal Ni. Furthermore, we also the investigated the cross-sectional configuration to protect the Bi-2212 highly c-axis oriented structure using metal Ni composite. Fig.1 shows the conceptual wire configuration of the high mechanical strength Bi-2212/Ag round wire using the metal Ni sheath material. Sample A is the conventional Bi-2212/Ag round wire via Powder-In Tube (PIT) process. Sample B is Bi-2212/Ag wire (Sample A) cladding Ni outer sheath. Sample C is the seven multifilamentary wire using Sample B. Typical optical microscopic photographs of the cross-sectional area in Sample A and B is shown to Fig.2. These wires have 1.04 mm in diameter. In the both Sample A and B, it was suggested the good wire deformation without breaking of wire. This will be caused by the good adhesion between Ag and Ni. Fig. 3 shows that typical optical microscopic photographs of the cross-sectional area in Sample C. We succeeded to fabricate Bi-2212 round wire having seven filaments cladding metal Ni shown to Fig. 3. However, the defect reduction of the Ni clad sheath in order to protect Bi-2212 filament core was observed locally. This will be caused by the different criteria of stable wire deformation between Ag and Ni.

In the feature, we will investigate the change of the transport I_c property by the bending strain in the Bi-2212/Ag round wire cladding metal Ni. Furthermore, optimum cladding metal compared with the Ni will be explored.

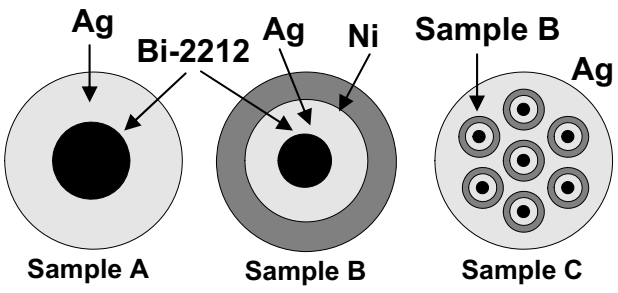

Fig. 1 Typical cross-sectional configuration of high mechanical strength Bi-2212 round wire using metal Ni sheath material.

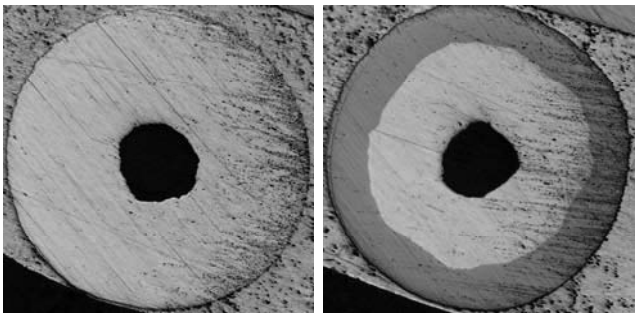

Fig.2 Typical optical microscopic photographs of the high mechanical strength Bi-2212 mono-cored round wire using metal Ni sheath material (Sample A and B).

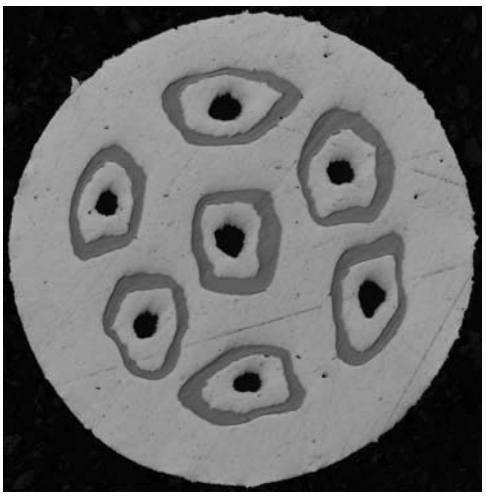

Fig.3 Typical optical microscopic photograph of the high mechanical strength Bi-2212 multifilamentary round wire using metal Ni sheath material (Sample C).