§10. Investigation of Feasibility of Remountable Superconducting Magnet for Helical Reactor

Ito, S., Hashizume, H. (Tohoku Univ.),
Sagara, A., Imagawa, S., Tamura, H.

A concept of the remountable HTS (high temperature superconducting) magnet, in which HTS magnet can be mounted and demounted iteratively with mechanical joint, was proposed, especially for helical reactors, to reduce fabrication cost of the magnet and maintenance cost of the reactor.[1] Butt joint of HTS cable where cross sections of HTS cables are jointed mechanically has been investigated as a fundamental study to realize the remountable HTS magnet.[2] In this study, stress distribution inside the HTS cable is evaluated by structural analysis to achieve structural optimisation of the butt joint. Then, the butt joint of reinforced HTS cables is performed to confirm the result obtained by the structural analysis.

Fig. 1 shows experimental set-up which is analysis object for the structural analysis. The joint surface is inclined at a 45-degree angle with respect to the cable length direction. Joint region is loaded by the compressive rod. In this figure, concentrated load acts only on the upper side. It is predicted that a uniform stress distribution is achieved with a dual loading system, where the concentrated load acts on both the upper and bottom sides of the cable. Stress distribution inside the cable in the two cases are evaluated in this structural analysis with FEM method. The result shows that dual loading system can achieve relatively homogeneous stress distribution. Fig. 2 shows the result of distribution of stress component which is perpendicular to the cable direction in the case of the dual loading. According to this figure, large tensile stress exists in the cable except in the region where the rod touches. This tensile stress induces layer peeling. Therefore, the tensile stress must be suppressed by fixing the cable with metal plates or something in real case.

Fig. 3 and Fig. 4 show experimental results of the butt joint of 10-layered BSCCO 2223 cable without and with SUS304 supporting structure, respectively. The experiment is performed with dual loading. From these results, the supporting structure can prevent material degradation of the cable and can reduce joint resistance.

From mentioned above, the way to prevent material degradation of the cable and to reduce joint resistance was suggested in this study. As a next step, more reinforced HTS cable, for example cable-in-conduit will be used for the butt joint to improve joint performance more. In addition, applying electromagnetic force obtained by helical magnet will be considered with structural analysis.

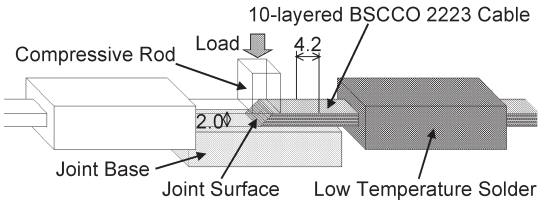

Fig. 1 Butt joint of laminated HTS cable

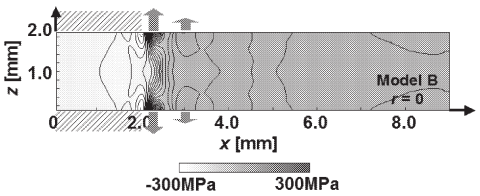

Fig. 2 Distribution of stress component which is perpendicular to the cable direction

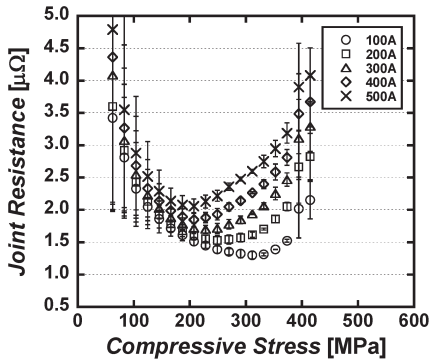

Fig. 3 Stress-resistance Characteristic in dual loading

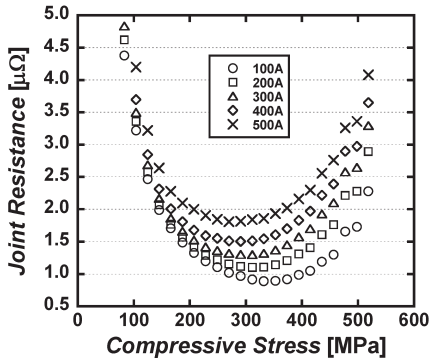

Fig. 4 Stress-resistance Characteristic in dual loading with SUS304 supporting structure

References
1) Hashizume, H. et al, Fusion Eng. Des. 63-64 (2002) 449.
2) Ito, S., Hashizume, H., Fusion Eng. Des. 81 (2006) 2527.