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

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Remountable high temperature superconducting magnet, whereby parts of the magnet are mounted and demounted iteratively, is a new design concept of a superconducting magnet proposed by our research group. [1) This concept has possibility to solve engineering problems such as construction cost and maintenance cost of a helical reactor. This study has been conducted to investigate feasibility of the remountable magnet for a helical reactor. In this year, two evaluation are performed; Experimental evaluation of joint resistance in mechanical butt joint of a BSCCO 2223 conductor with copper jacket; Analytical evaluation of temperature increase at a joint region of the remountable magnet with steady state heat generation induced by joint resistance.

Fig. 1 shows a BSCCO 2223 conductor with copper jacket used in the experiment. Critical current of this conductor is 900A at 77K and self magnetic field. Two kind of test cable are prepared for the experiment; An indium film of 50μm thick is inserted between the joint surfaces which are only polished; An indium film of 50μm thick is inserted between the joint surfaces which are silver-plated of 5μm thick. In this experiment, the test cables are mechanically butt jointed in liquid nitrogen. Fig. 2 shows joint stress-joint resistance characteristics obtained by this experiment when applied current is 500A. The experimental result indicates that joint resistance without silver-plating becomes smaller than with silver-plating. The difference of joint resistance between the two cases could be caused by Ag-In interface. The resistance at the interface is desired to decrease in a future work because metal-coating on joint surface is effective to prevent the joint surface from degrading.

Fig. 3 shows a model for the analytical evaluation. In this numerical analysis, a mechanical joint region of a HTS conductor, where transport current of 100kA flows, is assumed to be cooled by saturated liquid nitrogen. In addition, metal porous media is set into cooling channel along the joint region to enhance heat transfer. The heat transfer coefficient of the liquid nitrogen at the porous media is given by an experimental result that we obtained. Fig. 4 shows temperature distribution in the cases with and without the porous media. The results indicate that the maximum temperature at the joint region in the case with the porous media can be suppressed at 80.20K whereas that without the porous media is 86.06K.

From mentioned above, the experimental and the analytical evaluations were carried out in this year. For the experimental evaluation of mechanical butt joint, optimizations of coating method to a joint surface and conductor structure. In addition, structure of a joint region and influence of electromagnetic force on joint region will be discussed based on thermal analysis, electromagnetic field analysis and structural analysis.

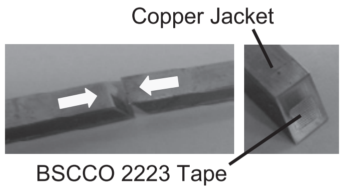

Fig. 1. BSCCO 2223 conductor with metal jacket.

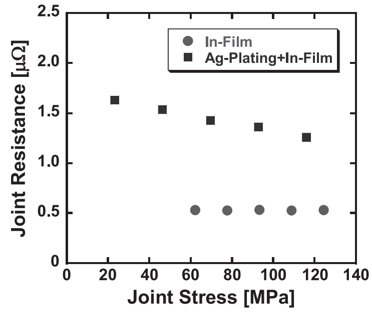

Fig. 2. Joint stress-joint resistance characteristics.

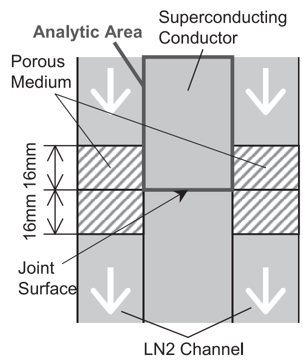

Fig. 3. Analytical model of joint region.

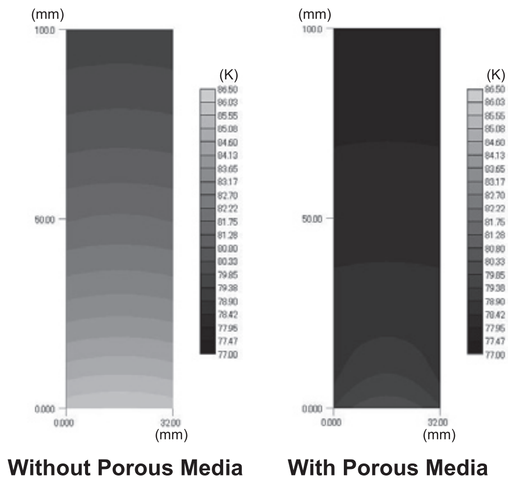

Fig. 4. Temperature distribution at joint region obtained by the numerical analysis.

1) Ito, S., Hashizume, H.: Fusion Eng. Des. **81** (2006) 2527.