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Influence of high thermal conduction plastic having negative thermal expansion property on cooling performance in conduction cooled HTS coils

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A glass fiber reinforced plastic (GFRP) has been widely used for electric insulation in a high temperature superconducting (HTS) winding. Since thermal conductivity in the GFRP is low, the GFRP makes thermal flow from the superconducting winding to a cold head of a refrigerator worse. When a high thermal conduction plastic is used instead of the GFRP, the cooling performance in the winding becomes better. We have experimentally and numerically studied increase of cooling performance in the winding having the high thermal conduction plastic sheet. In the plastic sheet, high thermal conduction fibers are embedded perpendicular to the sheet, and hence the thermal conductivity to the direction is good. At first, we measured the thermal conductivity along the fibers in the plastic. According to the experimental results, the thermal conductivity of the plastic was 20 times larger than that of the GFRP. And next, thermal expansion/contraction property of the plastic was estimated experimentally. The experimental results said that the plastic expanded approximately 0.2% to the fiber direction during cool down from room temperature to liquid nitrogen temperature. Finally, a YBCO tape was holed from upper and lower faces with the plastic sheets, and the tape quenched with the local heater put on the tape. From the quench tests, thermal stability of the tape with the high thermal conduction sheets was higher than that with the GFRPs. We used a 3D-FEM software and numerically simulated the quench test. From the calculated results, contact thermal resistance between the YBCO tape and the plastic sheet was about a half value of that between the YBCO tape and the GFRP. From those experimental and numerical results, we think the plastic sheet is useful to increase the thermal stability of the HTS winding.
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