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Numerical Evaluation of Reinforcement Structure against Electromagnetic and Thermal Stresses in Stacked REBCO Pancake Coils

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REBCO wires have high thermal stability and high current density, therefore, it is expected to be applied to high magnetic field magnet for NMR, MRI, and accelerators. On the other hand, there is the problem such as mechanically deteriorations and damages of REBCO coils. Because REBCO wires are tape shape, when charging and discharging, screening currents are induced to circulate in the windings. Screening currents lead to not only the irregular magnetic field but also the additional force and stress. It has been reported that REBCO coils have experienced mechanical deteriorations or damages when operating under high magnetic fields. In previous study, we showed that the mechanical deformations of REBCO coils due to screening-current-induced force are remarkably different from those of conventional coils.

In this study, reinforcement effects against electromagnetic and thermal stresses in insert REBCO coils of high field magnet are numerically evaluated. In this simulation, we evaluate stress and deformation of REBCO coils taking mechanical stress during winding process, thermal stress during cooling down and electromagnetic stress including the screening-current-induced stress during charging and discharging processes by using the our developed 3D electromagnetic numerical simulation code. And we investigate the reinforcement effect of over-banding, frame-reinforced structure such as YOROI structure, and hybrid structure combining these., and discuss the relationship between the stresses in REBCO coil and the limitation of the tensile stress in the longitudinal and width direction, the compressive stress in transverse direction of REBCO tape.

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