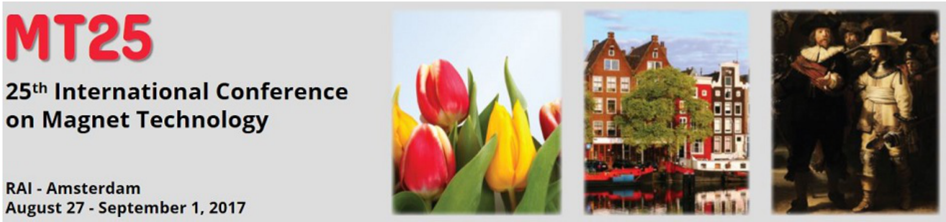

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Numerical simulation of electromagnetic and thermal hoop stresses in REBaCuO superconducting ring and disk bulks reinforced by stainless steel ring with various thicknesses during field-cooled magnetization

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RE-Ba-Cu-O (RE: rare earth element or Y) bulk superconductors have promising potential to be used as a strong trapped field magnet (TFM), which ever can trap a field of over 17 T on a Gd-Ba-Cu-O disc bulk reinforced with the shrink-fit steel. Ring-shaped bulk cylinders with a concentric hole are also considered in practical applications, such as nuclear magnetic resonance (NMR) spectrometer and a magnetic resonance imaging (MRI) apparatus. Since bulk superconductors suffer Lorentz force due to the current-field interaction between induced persistent current and magnetic field during magnetization process, the reinforcement by a metal ring against the electromagnetic hoop stress must be considered to avoid the fracture behaviours of the bulks for the practical applications. In this paper, we analysed the electromagnetic stress (hoop stress and radial stress) in finite-height RE-Ba-Cu-O bulk superconductors with various geometries, including both disc- and ring-shaped bulks when fully activated by field cooled magnetization (FCM) from 20 T at operating temperature of 50 K, using the finite element method (FEM) based on both electromagnetic and elastic equations. The trapped field and electromagnetic hoop stress was compared between those bulks. To discuss the effectiveness of the reinforcement, a stainless steel ring with various thicknesses was fitted for each bulk. Analytical results show that the hoop stress, which concentrates at inner periphery of the ring bulk, was remarkably alleviated by the mechanical reinforcement by the stainless steel ring. The thermal compressive stress by a stainless steel ring, which was due to the difference of the thermal contraction coefficient between the ring and bulk, was also considered when cooling from 300 to 50 K. A scheme to reduce the electromagnetic and thermal hoop stress by the optimal reinforcement is proposed.

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