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Assessment of Critical Factors Affecting the Performance of Trapped Field Magnets using Thin Film Superconductor Tapes

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Thin film superconductor tapes are composites with 98% metallic content and so, Trapped Field Magnets (TFMs) using such tapes can be much more robust than those using bulk superconductors. Trapped magnetic field profiles were investigated in Zr-added (Gd,Y)Ba2Cu3Ox tapes stacked in a criss cross configuration with three 12 mm wide tapes per layer. A crisscross arrangement of the tapes was found to yield a more uniform trapped field profile than a straight arrangement. Also, the decay of the trapped field with increasing distance from the tape stack surface was found to be less in the crisscross arrangement. Among tapes with 0%, 7.5% and 15% Zr addition, those with 7.5% Zr addition led to the highest trapped magnetic field at 77 K. Also, the trapped field increases and the time dependent decay of the trapped field decreases with increasing number of layers of tapes in the stack. A logarithmic time-dependent decay of trapped field was observed in all tape stacks, consistent with thermally-activated flux creep.

The profiles and the magnitude of the trapped fields obtained from the simulation match well with those obtained experimentally. At all temperatures from 30 to 77 K, the trapped field values increase non-linearly with increasing number of layers in the stack. Further, the maximum trapped field values from simulation increase with decreasing tape thickness from 0.055 mm to 0.02 mm i.e. with increasing number density of tapes in the stack. Unexpectedly, at 77 K, a sharp rise in trapped field values was seen at a tape thickness of 0.03 mm. Trapped field values at 77 K at 1 mm from the surface of stacks with 0.02 mm tapes reached nearly 2 Tesla in the simulation, which is above that feasible with permanent magnets.

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