Trapped Field Superconducting Magnets

Selva, Kavita

Recently, there has been a world-wide supply problem with rare-earths and so, there is a great incentive to develop strong magnets with reduced amount of rare-earths. Superconductors are one such potential candidate. The purpose of this project was to determine how the magnetic field trapped by a stack of superconductor tapes is influenced by the content of nanoscale defects in the tapes and by their critical current in a magnetic field. Three $(GdY)Ba_2Cu_3O_7$ superconductor tapes, with 0%, 7.5% and 15% zirconium addition with increasing density of nanoscale defects were used. Each of the three tapes were used to fabricate tape stacks with 128 layers in a criss-cross arrangement, which yielded a more uniform trapped magnetic field profile. Trapped-field measurements were conducted using a Hall probe that was scanned over the stack at 77 Kelvin. The results of this study show that the trapped magnetic field in superconductor tape stacks at 77 K increases with increasing critical current, but not with the increasing nanoscale defect density. A logarithmic time-dependent decay of trapped magnetic field was observed in all tapes, consistent with the phenomenon of thermally-activated flux creep. Surprisingly however, the rate of decay of trapped field was found to be the least in the tapes with the least density of nanoscale defects. The finding that the trapped field increases with increasing critical current and thickness of the tape stack can enable superconducting magnets with even higher trapped fields. Since the rare-earth content in the superconductor tape stack used is 120 times less than that in a Nd-Fe-B permanent magnet, trapped field superconducting magnets can benefit applications where rare-earths are abundantly used, such as wind generators and electric motors.

Awards Won:

Third Award of $1,000