Trapped Field Magnets with Thin Film Superconductor Tapes

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Rare earth materials such as neodymium are used in permanent magnets that are employed in wind turbine generators; a 6 MW wind turbine uses about 3600 kg of neodymium! Recently, there has been a world-wide problem with rare-earth supply. So, there is great incentive to develop strong magnets with no or minuscule amount of rare-earths. Superconductor tapes, made by coating a thin film on a flexible metal tape, are nearly rare-earth free; it was shown that these tapes can trap magnetic fields and hence work as magnets. The purpose of this project was to determine how the magnetic field trapped by a stack of superconductor tapes is influenced by the number of layers, number density of the tapes and by the operating temperature. Trapped-field measurements were conducted with a Hall probe that was scanned over the tape stack at 77 K. It was found that the trapped field increases and its time dependent decay decreases with increasing number of layers. Simulation of the trapped field profiles was done with COMSOL. The magnitude of the trapped fields from the simulation matches well with experimental results. It was found that the maximum trapped field values increase with decreasing temperature from 77 K to 30 K. Further, at all temperatures, the maximum trapped field values increase with decreasing tape thickness from 0.055 mm to 0.02 mm i.e. with higher number density. Trapped field values reached nearly 2 Tesla, well above that feasible with permanent magnets. The simulation data was experimentally verified with 0.025 mm thick tapes that were uniquely made. Since the rare-earth content in the superconductor stack is 120 times less than that in a permanent magnet, trapped field magnets can greatly benefit applications such as wind generators and electric motors.

Awards Won:

European Organization for Nuclear Research-CERN: Third Award $500