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Performance of a test coil wound from defect-tolerant second generation cable

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After more than 20 years of development, the manufacturing of high-temperature superconducting (2G-HTS) wire has been quite well established: a thin (1-2 microns) layer of YBCO superconductor epitaxially deposited on a biaxially aligned metal substrate. Such a conductor is very susceptible to current blocking defects. These defects are typically caused by mishandling of the tape between the processing steps, failures of epitaxy, deposition system malfunctions, etc. Currently, in the manufacturing of 2G tape, a series of quality control procedures are carried out to reveal the YBCO layer imperfections. It was discovered, however, that some defects remain undetected by off-line quality control methods. Such defects are most often hidden until they reveal themselves during low-temperature high-current tests when they result in a magnet failure.
Here we report the performance of a coil wound from a defect-tolerant superconducting cable. The defect tolerance is achieved by continuous current sharing between the filaments. The cable is comprised of a stack of four 2 mm wide filaments. The current sharing is achieved by fusing the filament during the winding process with a directed hot air stream. To demonstrate the concept, each of the four filaments in the cable was cut on purpose, resulting in the superconducting layer breakage every 2 meters. The coil was tested in field up to 1 T at 77 K and 4.2 K. We show that despite discontinuities in each of the filament the winding demonstrated no dissipation below the critical current down to the level of 10 nV over 5 meters of winding. We propose the design of a multi-filamentary cable that would be tolerant of current blocking defects several meters apart.
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Primary authors: SOLOVYOV, Vyacheslav (Brookhaven Technology Group); GUPTA, Ramesh (BNL); Mr WILLIAM, Sampson (Brookhaven National Laboratory); Mr MENDLESON, Zachary (Brookhaven Technology Group); Dr BEN YAHIA, Anis (Brookhaven National Laboratory)

Presenter: SOLOVYOV, Vyacheslav (Brookhaven Technology Group)

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