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Development of round flexible HTS CORC® wires for fault current limiting applications

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Next generation electric power systems require higher capacity, efficiency, and stability to meet the demands of increasingly complicated grid systems. High-temperature superconductors (HTS) provide unique solutions to stringent operating requirements, including the ability to protect electric power apparatus and systems from large currents that can develop during a fault. The extensive development of Conductor on Round Core (CORC®) cables and wires has resulted in round, multifilament, REBCO conductors with critical current densities beyond 200 Am² at 77 K. The inherent fault current limiting capabilities of a short kA-class CORC® wire of less than 4 mm thickness are demonstrated in liquid nitrogen, developing nearly instantaneous voltages in excess of 20 V/m that increased to about 70 V/m within 15 ms of applied overcurrents up to 250 % of the critical current. Enhanced current sharing between tapes enabled by the CORC® cable topology appears to mitigate the issue of hot-spots caused by inhomogeneities on the HTS tape level by providing several alternate superconducting routes for current to bypass low I_c sections of the tapes. Operation of the CORC® FCL conductor in stand-alone operation and operated as part of a hybrid-cable system, in which the overcurrent is redirected to a normal conducting path outside of the cryogenic environment, are demonstrated without any degradation of the CORC® wire performance. The results show that highly flexible CORC® wires with record current densities are able to function as fault current limiters in which they develop record voltages per unit length of any HTS FCL cable without the need for resistive laminates.

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