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Simulation of current paths and their relaxation within the tapes of monolayer CORC cables

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The Conductor-On-Round-Core (CORC) is a promising design for obtaining cables made of second-generation high-temperature superconducting (HTS) wires. These cables are primarily intended for high-field magnets, but their small size and excellent current-carrying performance make them an attractive solution for AC power applications as well. The AC loss level is an important factor affecting the practical realization of HTS applications. In general, the AC loss of HTS strongly depends on how the current distributes inside the superconductor. In the case of CORC cables, the particular layout of the wires generates differently oriented magnetic fields on the two sides of the superconductor. In turn, this generates a current transfer across the thickness of the superconductor: this ultimately results in a non-trivial zig-zag shaped current pattern, which does not simply follow the direction of the wire. This contribution aims at investigating these current patterns and their influence on the transport AC losses of CORC cables. In particular, we found that the effect is strongly frequency dependent, fully developed at 50 Hz and vanishing in the limit of DC. For this work, we use a full three-dimensional finite-element model, including current components perpendicular to the tape surface. The model is based on the H formulation of Maxwell's equations implemented in the commercial software package COMSOL Multiphysics. The local current and field components are calculated by using curvilinear coordinates and periodic conditions. The anisotropy of the critical current density with respect to the crystal planes of the superconductor is also included.
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