Modelling and Comparison of In-Field Critical Current Density Anisotropy in High Temperature Superconducting (HTS) Coated Conductors

Di Hu[1], Mark D. Ainslie[1], Mark J. Raine[2], Damian P. Hampshire[2], and Jin Zou[1]

[1]Bulk Superconductivity Group, Department of Engineering, University of Cambridge, Cambridge CB2 1PZ, U.K. (e-mail: dh455@cam.ac.uk).
[2] Department of Physics, University of Durham, Durham DH1 3LE, U.K.

E-mail: Di Hu

Abstract — The development of high temperature superconducting (HTS) wires is now at a stage where long lengths of high quality are available commercially, and of these, (RE)BCO coated conductors show the most promise for practical applications. One of the most crucial aspects of coil and device modelling is providing accurate data for the anisotropy of the critical current density $J_c(B, \theta)$ of the superconductor. In this paper, the in-field critical current density characteristics $J_c(B, \theta)$ of two commercial HTS coated conductor samples are measured experimentally, and based on this data, an engineering formula is introduced to represent this electromagnetic behaviour as the input data for numerical modelling. However, due to the complex nature of this behaviour and the large number of variables involved, the computational speed of the model can be extremely slow. Therefore, a two-variable direct interpolation method is introduced, which completely avoids any complex data fitting for $J_c(B, \theta)$ and expresses the anisotropic behaviour in the model directly and accurately with a significant improvement in computational speed. The two techniques are validated and compared using numerical models based on the H-formulation by calculating the self-field and in-field DC critical currents and the AC loss for a single coated conductor.

Keywords (Index Terms) — Ac loss, critical current density (superconductivity), finite element analysis, high-temperature superconductors, numerical analysis.