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# Numerical modelling of HTS response to magnetic field in perpendicular geometry

The non-uniform magnetic field and current density distribution inside superconductors must be considered for properly assessing critical aspects in the design of high-field magnetic systems. Understanding the static and dynamic magnetic behavior of High Temperature Superconductors (HTS) has significantly progressed thanks to the development of space- and time-resolved experimental techniques. Among them, Magneto Optical Imaging (MOI) stands out as a non-destructive method capable of providing quantitative information on local magnetic flux distributions with micrometer-scale resolution [1].
In this work, we investigate the magnetic response of high-quality YBa2Cu3O7-x thin films deposited on single crystal substrates (MgO and YSZ). MOI measurements were performed at different temperatures, in perpendicular geometry, i.e., with the applied field directed perpendicularly to the HTS film. The MOI technique enables the direct reconstruction of the spatial distribution of supercurrent density and its dependence on the local magnetic flux density and temperature.
To complement and interpret experimental observations, we developed numerical simulations based on an H-φ formulation [2] on the FEM software COMSOL Multiphysics®. This approach accurately captures the electrodynamic behavior of the HTS film, including field penetration and current redistribution during applied field ramps. The agreement between simulated and measured magnetic field profiles validates the predictive capability of the numerical framework.
Overall, the combined experimental and numerical analysis demonstrates that the model provides a fast and reliable tool for investigating current limiting mechanisms, assessing sample inhomogeneities, and understanding the influence of microscopic defects, on the electromagnetic performance of HTS films. This achievement is of utmost importance for predicting the behavior of HTS tapes in high-field magnet designs.

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