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M3Or1A-01: [Invited] Overview of AC loss in ReBCO conductors and devices: simulation and experiment

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ReBCO coated conductors have been used in high-field magnets in excess of 30 T. Such devices are usually operated in quasi-steady state, where the magnetic field and current change only slowly. However, ReBCO coated conductors are also being considered for use in higher-frequency applications such as rotating machines, linear motors, electric aircraft and fast-cycling synchrotrons. Most ReBCO conductors are currently manufactured as coated conductors with wide flat superconducting filaments. Time-varying magnetic fields can induce large screening currents in such filaments. These screening currents have undesirable consequences including heat dissipation, magnetic field distortion and stress concentrations leading to degradation. Parallel connection of ReBCO tapes and operation at high frequencies can result in more complex patterns of induced currents. In this presentation, we will give an overview of efforts to understand these phenomena at the University of Twente. Specific projects include "High-dynamic Superconducting Linear Motor"(HSLM) [1], which aims to increase the power density of a linear motor by using ReBCO racetrack coils in the stator. In the "Advanced Superconducting and Cryogenic Experimental Powertrain Demonstrator"(ASCEND) of Airbus UpNext [2], ReBCO-CORC cables were used to reduce the weight of an electric aircraft powertrain. In Muon Collider project [3], the use of ReBCO in dipole magnets for a fast-cycling synchrotron has been investigated. In the frame of such projects, we performed AC loss calculations and measurements on ReBCO-based racetrack coils, pancake coils and multi-tape cables. The new insights into the AC loss in ReBCO, as well as the lessons learned regarding experimental techniques are presented.

[1] J. ter Harmsel et al., "Effect of a DC transport current on the AC loss in no-insulation ReBCO racetrack coils exposed to AC parallel magnetic field at 77 K and 4.2 K", Supercond. Sci. Technol. 36 075003, https://doi.org/10.1088/1361-6668/acd666
[2] S. Otten et al., "Calculation and Measurement of Transport AC Loss of ReBCO CORC Cables for Electric Aircraft", IEEE Transactions on Applied Superconductivity, vol. 34, no. 3, https://doi.org/10.1109/TASC.2024.3364120
[3] S. Otten et al., "AC loss calculation for RCS 1.8 T magnet (ReBCO-HTS option)", IMCC and MuCol annual meeting 2024, https://indico.cern.ch/event/1325963/contributions/5798918/

The valuable contributions of the many partners in the aforementioned projects are greatly appreciated.

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