Expose Master Thesis
Mechanical Engineering

Thermal resistance between metallic surfaces in different configurations for high current HTS Cable-in-Conduit Conductor.

High Temperature Superconductors (HTS) are promising candidates for high current Cable-In-Conduit Conductors (CICC) for large high-field magnets. In many cases, these CICCs are made from several HTS strands, which themselves consist of individual HTS tapes. Quench propagation is CICCs is currently under intensive investigation, and it can be predicted by modelling the entire cable structure. On the other hand, to model the heat transfer, along with material properties the thermal properties of contact interfaces between structural materials are highly needed. There are different kinds of thermal contacts in CICC: contacts between superconducting tapes stacked together, contacts between thin copper of stainless steel tapes, and between bulks of structural materials.

A behaviour of the thermal contact is strongly different at low and high T, since the electron and phonon transport mechanisms differ significantly for the low- and the high-T range. For the moment, there is no well-defined theoretical description of the temperature-dependent contact resistance in the intermediate temperature range from 20 K to 300 K. However, parameters can be tuned for achieving a better value of the contact resistance, i.e. loading pressure, geometry of the contact, surface roughness, art and thickness of an intermediate layer. Besides the complications with the theoretical approaches, there is a lack of experimental data. The values reported in the literature often differ by orders of magnitude, depending on the contacting material properties, surface quality and sample preparation conditions. Moreover, the thickness of materials, that are in contact, is one of important parameters. According to the elastic theory of bending, an increase in resistance per contact in a stack of metal plates with increasing thickness of metal is expected. Therefore, it is to assume, that the resistance of single contact between bulk materials, and between plates made of same materials in the stack, are quite different.

This work aims at characterizing the thermal resistance R_{TC}, which is defined as the ratio of the temperature difference ΔT across the interface to the heat power P flowing across it, i.e., $R_{TC} = \Delta T/P$ [K/W], of copper-copper and copper-stainless-steel interfaces systematically at different pressure and temperature ranges for the specific application for CICC. It includes the investigation of contacts having different geometries and surface qualities. The goal is to fill the gap in the reliable experimental data describing such thermal contact surfaces. The data should be further directly used for the modelling problem of a heat transfer in the case of fast transients like a quench in a superconducting cable. Using a specific cable design, the experimental data obtained together with the physical description the simulation will be benchmarked against existing. This will allow further simulations of a quench in various CICC cable.

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Topic / Month	1	2	3	4	5	6
Literature work	■					
Training and testing the measurement equipment		■				
Assembling the contacts in the frame and testing them in PPMS		■	■	■	■	
Assessment of results				■	■	
Written documentation of Master Thesis, preparation of presentation					■	■