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Options for epoxy impregnation of REBCO Roebel cables

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REBCO Roebel cables combine high current density with low AC loss, and as such are promising for HTS inserts in high-field accelerator magnets (up to 20 T). The Lorentz forces in these magnets accumulate over the windings and may lead to local stress concentrations in the cable structure. An appropriate impregnation of Roebel cables –and eventually coils –redistributes these forces, and thus increases the transverse cable strength.

Epoxy impregnation of REBCO cables and coils is challenging: first, REBCO tapes are known to delaminate under transverse tensile stresses, which may arise due to a thermal expansion mismatch with the epoxy. The punched Roebel strands are especially susceptible to this, because the copper sheath is removed at their edges. Second, the REBCO layer can be chemically affected, since it is directly exposed to the impregnation material. Finally, impregnation may decrease the stability of the cable if the strands become thermally or electrically isolated.

We report on the impregnation of Roebel cables with epoxy resins loaded with different fillers (alumina, quartz, silver, graphite) to tune their thermal conductivity, electrical resistivity and thermal expansion. The impregnation methods are first tested on single REBCO tapes and steel Roebel dummies, to ensure that the strands are not damaged and that the epoxy penetration is adequate. Impregnated cables are then subjected to thermal cycling and checked for degradation. Finally, the transverse pressure dependence of the critical current of a suitably impregnated cable is tested in conditions close to those inside an accelerator magnet ($T = 4.2$ K, $B = 11$ T).

Primary authors: KARIO, Anna (KIT); Mr OTTEN, Simon (EMS, UTwente and ITEP, KIT)

Co-authors: Ms KLING, Andrea (ITEP, KIT); Dr DHALLÉ, Marc (EMS, UTwente); Dr BAGRETS, Nadezda (ITEP, KIT); Mr GAO, Peng (EMS, UTwente); Dr NAST, Rainer (ITEP, KIT); Mr WESSEL, Sander (EMS, UTwente); Dr DROTZIGER, Sandra (ITEP, KIT); Mr WALSCHBURGER, Uwe (ITEP, KIT); Dr GOLDACKER, Wilfried (ITEP, KIT)

Presenter: KARIO, Anna (KIT)

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