Notes from WP10.2 meeting 27/8/2020

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Results of BSCCO-2212 cable test of Ic under transverse pressure – M. Dhalle

M. Dhalle reports on the main results of the test of BSCCO-2212 cable from Berkeley (details provided by T. Shen later), coordination and sample holder from CERN, heat treatment in NHMFL-ASC, measurement in Twente. Thanks expressed both from the side of CERN and US.

Sample preparation revealed the cable legs had moved during the HT, laterally, resulting in some gap with respect to the reaction holder. After the transfer the mis-match was filled with resin during the impregnation (CTD-101K). There was some deposit on the cable that was polished away before joining over a relatively long length (2 twist pitches, order of 1 nanoOhm joint resistance). Autopsy of the sample after measurement shows that the impregnation has a good filling. M. Dhalle will complete the documentation on the test set-up, which includes the improvement introduced in the last months (alignment, voltage tap and analysis), and comment on possible improvement of the sample for BSCOO-2212 testing.

Ic measured with no pressure shows a relatively low Ic and n. More from in the information provided by T. Shen (see later).

Ic under pressure shows a plateau going to about 130 MPa, after which Ic (138 MPa) and n (approximately 145 MPa) degradation starts appearing. MD remarks that in the data there is no clear evidence of a reversible behavior, though the “noise” may not allow drawing definite conclusions as this is expected to be a small effect.

As a conclusion, this cable seems to have no reversible degradation, and irreversible degradation starting at 140 MPa. The measurement is self-consistent (V-taps) and the procedure (HT, transfer and impregnate) has been validated as far as possible.

BSCCO-2212 cable characteristics – T. Shen

The cable tested at Twente was traced as manufactured at FNAL, ID: R+DT_090520_24_0. This was a contribution to the VHFSCM collaboration. The strand was manufactured in 2005, as part of US-CDP. The powder source was SCI. Ic at 11 T is about 75 A, i.e. modest. The same strand was used in SC04 and SC06 short coils in LBNL. This is a first-generation strand and cable, of a power braand and architecture no longer in use, and superseded by present state-of-the-art.

DL and other point to the fact that this strand and cable is not representative of present performance, and was coming from a time when many of the effects and the influence of parameters was not fully understood. Though the result of the tests are important, more work

is desirable on state-of-the-art wires and cables. Material is available in the US to initiate this work.

LB remarks that an effort to trace and check consistency remains important to identify any inconsistency that could point to issues in the way strands and cables are tested for this delicate measurement (Ic vs. transverse stress)

Results of single wire tests – C. Senatore

The results of the single wire tests performed within the scope of the EuCARD2 program are recalled. Wire samples (pmm130723, 37x18, 0.8 mm, OPHT at 100 bar) were measured in the transverse stress Ic set-up at University of Geneva. Irreversible damage in the wires appears at 70 MPa. A OPHT wire (same type) at 10 bar has about 10 MPa difference. The data is rather consistent (Ic and n value).

The following discussion revolves around two points. This strand was produced with powders from NSC lot 82, the state-of-the-art at the time, but this lot has been found to leave particle residues after HT. This could affect the stress tolerance. Also, the correspondence of wire and cable results is not trivial. DL points to the difficulty of understanding the local distribution of stress, and hence translate average pressure in actual values that applies to cables (and magnets). LB remarks that for Nb3Sn this seems to yield now rather consistent results, but this required time.

Discussion

The strand and cable are an old generation of material, and now it is difficult to complete the set of information required to understand and verify the consistency of the results obtained. At the same time new generations of BSCCO strands may have different behavior and threshold, so there is a general agreement that a new test campaign, to be defined, would be a useful next step.

This would involve repeating the measurements to generate a consistent set of data using the latest generation of strand and cable (different powder source, strand architecture). There is agreement that the measurement should be made in Geneva and Twente, where infrastructure and know-how is the highest.

HTK has interest in a small program in this direction, and points to the fact that what is also of relevance is the cycling behavior in reversible regime, rather than the limit. The test protocol may need a modification in this direction.

LR recalls the complementarity of EuCARD2 and the US programs (REBCO vs. BSCCO). He also acknowledges the value of this work, keeping in mind the complementarity of EU and US programs.

LB suggests that the US-MDP side proposes an experimental plan, based on relevant (last generation) material, and available for testing. He also suggests for the moment to focus on the scientific aspects of the work, whereby a discussion on how to organize the collaborative effort will have to follow.

This is broadly agreed. TS will formulate a proposal, to be iterated with MD and CS as to the measurement aspects, and discussed by end of September 2020 in a follow-up meeting.