Post Quench Behavior of a Metallic Cladding (MC) No-Insulation (NI) Coil

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Introduction

A metallic cladding (MC) no-insulation (NI) REBCO coil was constructed and tested. A key idea of the MC technique is to substantially reduce the charging delay of a conventional NI coil. The results confirmed that the use of MC tape may be an alternative way to reduce the charging delay of conventional NI magnets without sacrificing the self-protecting feature at a coil current density (J_e) up to 820 A/mm^2[1]. However, during a long-term quench recovery test, a 15 T background magnet was quenched 30 s after the MC coil's quench at 820 A/mm^2 (**Fig.1**). We report details of the MC coil test results and our post-mortem analysis on the MC coil.

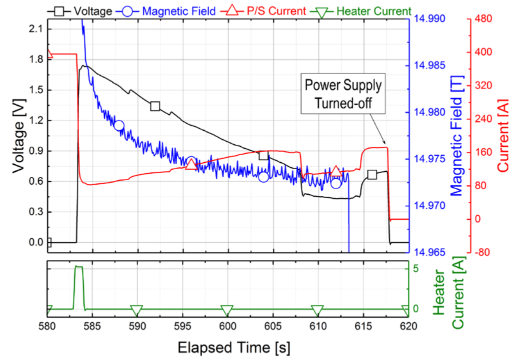

Fig.1 Quench of an LTS background magnet.

Post-Quench Analysis

Fig. 2 shows lengthwise I_c test results using the YateStar ($B_{\parallel c}$ of 0.6 T), where a periodic damage pattern was observed: a 10.4 cm damage period was found in the inner pancake section and 12.5 cm in the outer section. These periodicities agree well with the perimeter of each section. The results imply that the damage was "localized" and propagated in the radial direction. After the YateStar test, a visual inspection was performed on the tapes and localized "spot" damages were visually identified near the innermost turns (**Fig. 3**). Note that the first ~4 cm of the 1st turn is attached to the current lead and was cut-off prior to YateStar measurement in **Fig. 2**. The peel-off of the stainless steel layer was observed at the rear of the damaged turns as seen in **Fig. 3**, where bottom and top pictures correspond to the respective front and real side of the tape.

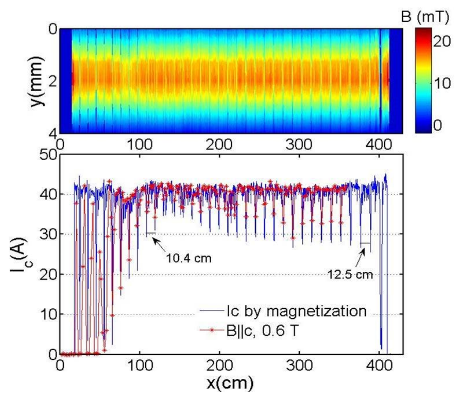

Fig.2 YateStar results of the damaged MC tape after the background magnet quenched.

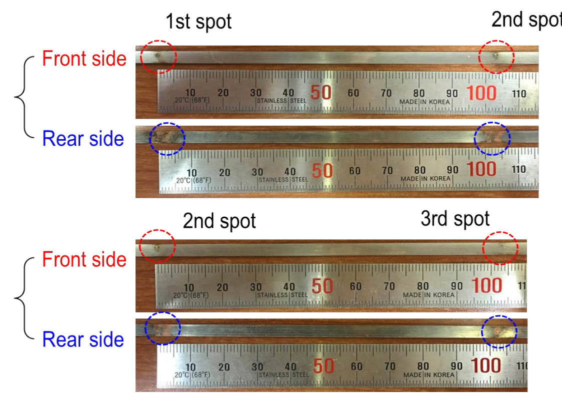

Fig.3 Pictures of the damaged spots and peel-off of stainless steel layers.

Conclusions

The MC coil survived after multiple quench tests at its average coil current density up to 820 A/mm^2, which implies a strong potential of the MC technique to mitigate the charging delay of an NI coil without sacrificing the self-protecting feature. Yet, localized damage of the MC coil was observed after an unexpected LTS background magnet quench. From our post-mortem analysis with YateStar, a periodic damage pattern was observed that we interpret to indicate radial propagation of the damage. We understand that peeling of the stainless steel cladding layer may be a primary reason for the damage, as a large induced current may have been concentrated in such local spots, which ultimately leads to excessive heat generation. More studies, experimental and analytic, are in progress to better understand the quench behavior of MC coils.

Acknowledgements

This work was supported by the National High Magnetic Field Laboratory (which is supported by the National Science Foundation under NSF/DMR-1157490), by the State of Florida. It was also supported by the Korea Basic Science Institute (KBSI) grant (D36611) to S.-G.L.

Reference

[1] Kim, K., *et al.*, Supercond. Sci. Technol., **30**, 075001 (2017).