Stacked-Tape Twist-Wind YBCO Cable Test

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Introduction

We have been developing a cabling method for HTS tapes which is a twisted, stacked-tape geometry applicable to high current, high field magnet applications [1]. The twisted, stacked-tape cabling (TSTC) method allows developments of high current, compact conductors for various applications such as power transmission cables and high field magnets. For magnet applications using TSTC, we have been developing a new magnet winding method called the Stacked-Tape Twist-Wind (STTW) technique, suitable for the fabrication of complicated 3D windings of 2G HTS tape cables for various high energy accelerator magnets. This year we fabricated and tested two small pentagonal-shape coils.

Experimental

Two 2.5-turn pentagonal-shape coils were fabricated. They were wound in a groove on a 165 mm diameter pentagonal cylinder by the Stacked-Tape Twist-Wind technique. Both coils were made with a cable composed by 50 stacked-YBCO SuperPower tapes 0.1 mm thick and 4 mm wide . They were tested at 4.2 K in Cell 4 using the 20 T, 195 mm warm bore Bitter magnet. Sample current was provided using a 20 kA, 10 MW Bitter magnet DC power supply through a 4.7 m-Ohm stainless-steel tube resistor of Cell 4 connected in series with the test sample.

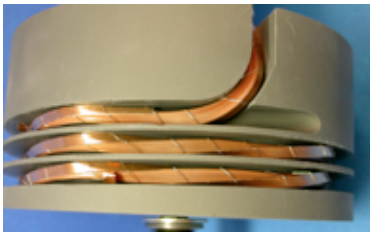

Fig. 1. 2.5-turn coils of 50-stacked-tapes YBCO cable wound in a groove on a 165 mm diameter pentagonal cylinder by STTW winding technique.

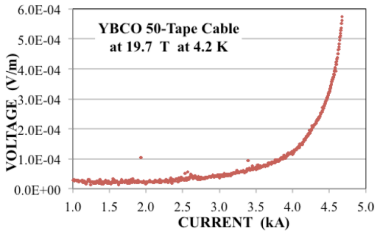

Fig. 2 I-V curve of the 50-tape YBCO coil composed o 4 mm wide YBCO tapes, measured at 19.7 T and 4.2 K.

Results and Discussion

The test result of an I-V curve of 1 m voltage tap at the background field of 19.7 T at 4.2 K for the first sample is shown in Fig. 2. The critical current at the criterion of 100 μV/m was 4.0 kA with a low n-value of 12. The cable quenched at 4.7 kA. The sample was apparently degraded. It is believed that it was caused by the Lorentz force, since the cable itself was soldered between the stacked tapes but it was not well supported in the groove. Unfortunately the sample burned out after the first test run by an excess in current.

The second sample was not soldered between tapes but the conductor was supported with Stycast epoxy in the groove, and tested with the same 20 T magnet. The critical current of the sample was measured between 4 T and 20 T. The results showed noticeable degradation of the critical currents during tests. Also the I-V curves showed resistive components which became gradually more dominant. After the test operation, it was noticed that a high spike in current was produced each time when the sample current was dumped. It is under investigation if the sample degradation was due to the over-current.

Conclusions

The Stacked-Tape Twist-Wind (STTW) technique of the twisted, stacked-tape cable will be very useful for complicated 3D curved winding magnet fabrications using 2G tape cables. At high field and high current the electromagnetic Lorentz force will be significant and could affect the performance of cable windings of a magnet. Further investigations of cable supporting methods will be required.

Acknowledgements

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References

[1] M. Takayasu, *et al*., IEEE Trans. Appl. Superconduct., **21**, 2340-2344 (2011).