Critical Current Measurements of Stacked and Soldered Bi-2223 tapes for the Series-Connected Hybrid Magnet 20 kA Current Leads

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Introduction

The current leads for the Series-Connected Hybrid magnet outsert coil use high temperature superconductor (HTS) tapes to reduce the heat load to the magnet cryogenic system. Sumitomo Type G Bi-2223 tape is cut to length, soldered into stacks, and joined to the lead assembly. A total of 120 stacks of 6 tapes each are required for the pair of leads. After soldering, each stack is tested for critical current (I_c) for quality control and to confirm design assumptions.

Experimental

A total of 134 stacks were made and then tested in batches of six on a fixture fitted with clamped current connections and spring-contact voltage taps, shown in Fig. 1. The fixture was immersed in liquid nitrogen and current was ramped up until the superconducting transition voltage was observed.

Figure 1. Fixture for testing critical current of stacked and soldered HTS tape conductors

Results and Discussion

The conductor was supplied in four separate piece lengths. The critical current of each stack, and the average critical current of the stacks by spool are graphed in Fig. 2.

The 'stacking ratio' is defined as the stack critical current divided by the sum of the critical currents of the individual conductors. It is a measure of the suppressive effect of the increased self-generated magnetic field on the critical current.

The piece length critical currents, the average, and standard deviation of critical current for the stacks from each piece length, and their stacking ratios are listed in Table 1.

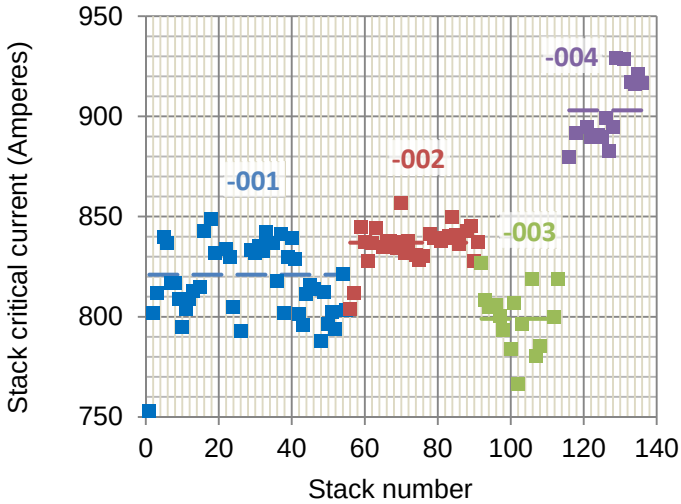

Figure 2. Critical current of each tape stack and average stack critical current by conductor piece

Table 1. Stack critical current measurement results by conductor piece

Piece number	Piece I_c	Ave Stack I_c	Std dev	Stack ratio
-001	203	818	18	0.67
-002	209	837	9	0.67
-003	200	799	14	0.67
-004	223	903	17	0.67

Conclusions

The test results for the self-field critical current of the HTS tape stacks for the SCH current leads are reported. When scaled for the fringe field and temperature of the leads during full-current operation, these results indicate that the design margin of safety for the HTS section of the leads is ~2.

Acknowledgements

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References

[1] Marshall, W.S., et al,"HTS Current Leads for the NHMFL Series-Connected Hybrid Magnet," IEEE Trans. Appl.Supercond., vol.23, no.3, 2013