Record Current Density in High-Temperature Superconducting CORC Cables at 17 T

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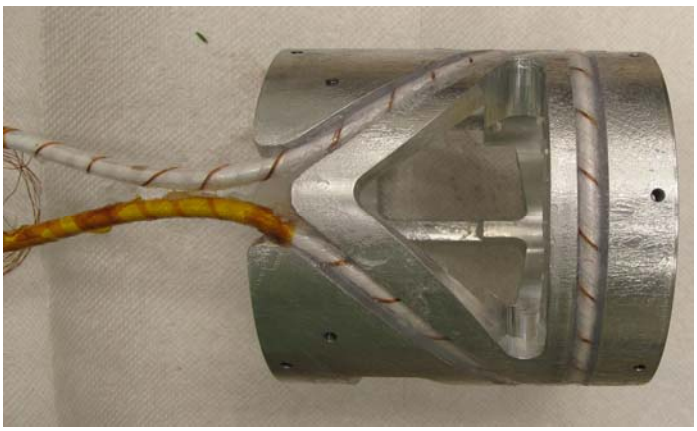
Introduction

The next generation of high-field superconducting magnets requires operating fields exceeding 20 T and that cannot be reached with low-temperature superconductors, such as NbTi or Nb_3Sn and high-temperature superconductors (HTS), such as $REBa_2Cu_3O_{7-\delta}$ (REBCO) coated conductors, are the only option. The measurements performed at the user facility of the NHMFL are in support of Conductor on Round Core (CORC) cable development [1-3]. This year we've reached a new record engineering current density J_e of 213 A/mm^2 at 4.2 K and 20 T (projected), making CORC cables the most promising HTS cables for high-field magnets.

Experimental

A 6 mm diameter CORC cable was wound from 50 superconducting tapes. The tapes were purchased from SuperPower and contained extra thin substrates of 38 μm thickness to help increase the cable current density. Figure 1a shows the cable wound in a 10-cm diameter loop onto the bottom part of the sample holder before testing at 17 T.

a. 

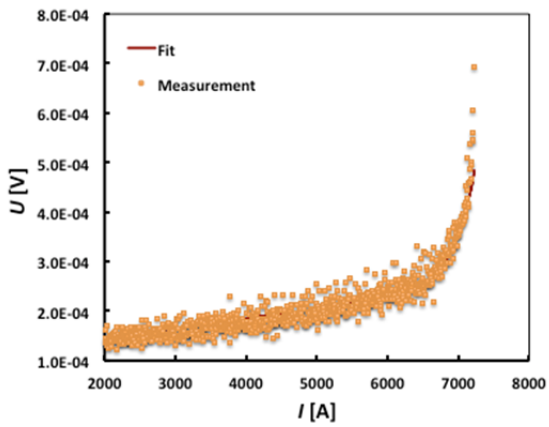
b. 

Figure 1. a) CORC cable wound at a diameter of 10 cm. b) Voltage vs. current at 4.2 K the CORC cable at 17 T.

Results and Discussion

The CORC cable shown in Fig. 1a had a critical current I_c of 6,966 A in a field of 17 T. The superconducting transition is shown in Fig. 1b, together with a fit to determine I_c. The current density of the 6 mm diameter CORC cable at 17 T was 246 A/mm^2. Based on the field dependence of I_c of CORC cables, J_e at 20 T is expected to be a record 213 A/mm^2, almost twice the old record of 114 A/mm^2.

Conclusions

The results obtained at the user facility of the NHMFL in 2014 clearly show the potential of CORC cables for use in high-field magnets. The record engineering current density at 20 T of 213 A/mm^2 confirms that CORC cables are suitable for use in magnets ranging from large fusion magnets operating at high currents to accelerator magnets operating at very high current densities.

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References

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