

## REBCO Coated Conductors for Magnets

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**Abstract**—Magnets are an important driver for coated conductor manufacture, especially now that compact fusion use presents an impressively large potential market for REBCO magnets. But operation in high magnetic fields at high current densities is sometimes unforgiving, as is well exemplified by the difficulty of making user magnets and the destruction of several high profile magnets by spontaneous and unprotected quenches<sup>1,2</sup>. High field magnets impose large stresses on magnets, whose magnitude is now understood to be amplified by screening currents<sup>3</sup>. Slitting damage is present in almost all conductors<sup>2</sup> since Coated Conductors are mainly used in widths narrower than their manufacturing width. Many, if not most, Coated Conductors are now fabricated with deliberately added nano-precipitates in order to optimize vortex pinning but in some cases there is clear evidence that this leads to run-to-run variability<sup>4</sup> and even to along-the-run variability<sup>5</sup> due to small perturbations to the epitaxial growth process in present-day 500-1000 m run lengths. Especially for solenoid magnet use, the large intrinsic electronic anisotropy leads to ~ 5 times higher  $I_c$  in central parts of the winding, as compared to the lower  $|B|$  end windings with high radial  $B$  where  $I_c$  is first exceeded<sup>6,7</sup>. This leads to interest in being able to use conductors from multiple manufacturers to provide a useful variation of  $I_c$  or perhaps to post-delivery deoxygenation heat treatments that controllably degrade  $I_c$  for central pancake use where parallel fields dominate<sup>8</sup>. But how can one decide between one manufacturer and another? Does one just decide on the basis of a few short sample  $I_c$  measurements or is a broader evaluation needed? For these and other reasons, the particular details of REBCO Coated Conductors in all forms of manufacture, field and temperature of use and variability in long length start to become of interest. My talk will summarize some of the viewpoints of my colleagues and me at the NHMFL on these issues.

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### References

1. K. Kajita *et al.* IEEE Trans. On Appl. Supercon. **26**, 4301106 (2016), Super. Sci. Tech. **30** 074002 (2017)
2. S. Hahn *et al.* Nature **570**, 497 (2019)
3. Jing Jia *et al.* Super. Sci. Tech. **32**, 095005 (2019)
4. A. Francis *et al.* Submitted to Super. Sci. Tech. October 2019.
5. L. Rossi *et al.* Super. Sci. Tech. **29**, 054006 (2016)
6. A. Xu *et al.* Super. Sci. Tech **23**, 014003 (2010).

7. H Weijers *et al.* IEEE Trans. On Appl. Supercon. **26**, 4300807 (2016)
8. G. Bradford *et al.* Presented at the 26th Conference on Magnet Technology (MT26) September 2019.

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