

Robust High J_c RE-Ba-Cu-O Symmetric Tape Round (STAR) Wire for Accelerator Magnets

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April 8, 2018 (STH56, HP131). The ultra-high critical magnetic fields of REBa₂Cu₃O_x (REBCO, RE=rare earth) High Temperature Superconductors (HTS) provide the opportunity for superconducting magnets that can operate well above 20 T. Several approaches for high-field accelerator magnets using REBCO cables are being developed including those based on the canted cos θ (CCT) design. An important requirement of initial CCT coils being constructed with HTS now is an engineering current density (J_c) of 600 A/mm² at 4.2 K, 20 T at a bend radius of 15 mm. The objective of our work is to develop a HTS wire to meet this key J_c and bend radius requirement of CCT coils.

AMPeers and University of Houston have jointly developed an innovative approach to fabricate round REBCO wires with high J_c and good bend strain tolerance [1]. These wires are only 1.6 to 1.9 mm in diameter and are made by winding narrow REBCO tapes on an AWG 18 (1 mm diameter) copper wire former. Such small diameter wires are possible by the use of symmetric tapes where the REBCO film is positioned at the geometric center, close to the neutral axis as shown in figure 1. Such a symmetric tape architecture is achieved by a strategic selection of the thickness of the copper stabilizer to match the thickness of the Hastelloy substrate. The substrate itself is made thin, about 22 μ m, so as to enable good tolerance to bend strain. The overall thickness of the REBCO tape is about 45 – 60 μ m including the copper stabilizer. Symmetric Tape Round (STAR) wires have been fabricated with six to eight of these REBCO tapes, each about 2-3 mm in width, wound on AWG 18 copper wire former. The optimized STAR wires are found to be mechanically robust and retain 97% of its critical current of over 500 A at 77 K, self-field even when bent to a small radius of 15 mm as shown in figure 2. Excellent in-field performance ($J_c > 450$ A/mm² at 4.2 K, 15 T) has been achieved as well at the bend radius of 15 mm. An article in IOP-SuST (Letter) has been published on such robust high J_c STAR wires with detailed performance studies under background field [1]. The superior bend

strain tolerance of STAR REBCO wires make them suitable for use in CCT coils for future compact accelerator magnet applications.

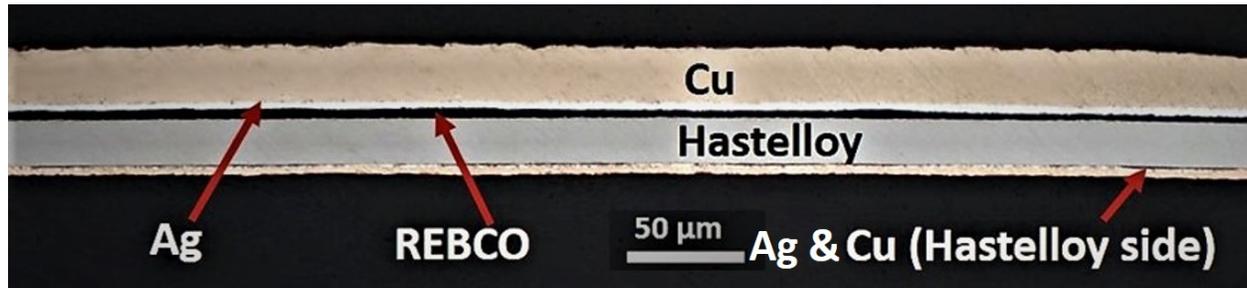


Fig. 1. In-house prepared thin symmetric REBCO tape with total thickness of 25 μm before copper plating, and 22 μm thick Hastelloy substrate. The REBCO film is positioned near the geometric center of the tape by incorporating appropriate copper stabilizer thicknesses on the film side and substrate side.



Fig. 2. REBCO STAR wire mounted for critical current testing on a G-10 fixture, bent at 15 mm radius along with its copper terminals

Acknowledgments

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References

1. S. Kar *et al.* “Symmetric tape round REBCO wire with J_e (4.2K, 15T) beyond 450Amm⁻² at 15mm bend radius: a viable candidate for future compact accelerator magnet applications”, *Supercond. Sci. Technol.* **31** 04LT01 (2018) <https://doi.org/10.1088/1361-6668/aab293>