Teaching an Old Dog New Tricks: Fifty Percent Increase in Critical Current for Ternary Nb_3Sn Wires with Artificial Pinning Centers

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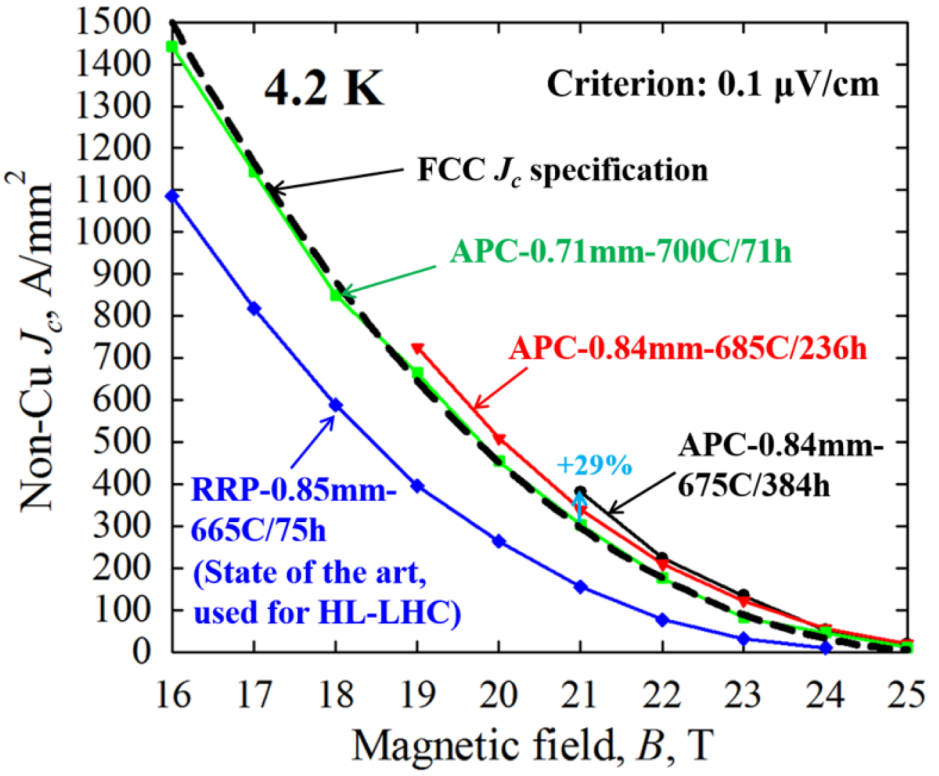
While recent years have witnessed rapid progress in developing high temperature superconducting (HTS) conductors, MagLab users have found a way to teach an old dog, Nb_3Sn, a new trick! Using a new growth technique to refine grains and pin magnetic flux using artificial pinning centers (APC), MagLab users were able to push the performance of the Nb_3Sn conductor well beyond a twenty-year-long performance plateau. *Indeed, this new Nb_3Sn growth technique achieves a 50% performance increase in the critical current (J_c) over the current state-of-the-art Nb_3Sn wire widely used in magnet construction today*.

The upper critical field (B_{c2}) and irreversibility field (B_{irr}) of wires with this new ternary-APC approach were measured using a electron transport technique in a 31T DC resistive magnet at the MagLab. Transport J_c values were also measured using a standard four point *I-V* technique in the same magnet.

The results show that ternary APC wires display both a high B_{c2} (28T) and B_{irr} (27T), roughly one to two teslas above present state of the art for optimized wires, These wires also display the highest non-copper J_c seen to date in the 16-22T regime **(see Figure)**.

These improvements in the 16-22T regime are critically important for the proposed Future Circular Collider (FCC) to be located at CERN, *representing a significant milestone for Nb_3Sn wire development of great importance for the multi-billion-dollar FCC project.* Such conductors also have potential applications in the production of magnets needed for NMR and high field MRI.



Non-Cu J_c-B curves of the APC wire given various heat treatments and the state-of-the-art Nb_3Sn wire as reference, as well as the FCC J_c specification

Facility used: DC Facility: 31 T resistive magnet (Cell 7).

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