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Progress on REBCO superconducting coatings for the beam-screen chamber of the FCC-hh

Since the late 1960s, superconductors are employed as materials for radio-frequency (RF) cavities because of its operation at higher acceleration voltage gradient and lower AC power demand than comparable normal conducting alternatives. In this field, elemental Nb is the most widely used material owing to its highest critical temperature Tc and highest RF critical field Hsh among the elemental superconductors.
Emerging high-energy physics technologies require excellent RF response under high-magnetic field; like CERN's FCC-hh next generation high-energy accelerator, which operates at 16T and 50K; or Dark Matter axion detection haloscope cavities, where the detection sensitivity scales as the square of the magnetic field. Therefore, at the operating conditions of these technologies, penetration of magnetic field lines into the superconductor is unavoidable and thus, its RF response is governed by vortex pinning. Under those conditions, NbTi and NbSn3 superconductors offer a very poor, lower-than Cu, RF response and the high-energy physics community turned its attention back to Cu. However, we demonstrated that under the very-high magnetic fields required for such applications, REBCO offers, opposed to Nb-based superconductors, outstanding, better-than-Cu RF response [1, 2] due to its higher critical temperature Tc > 90K, larger upper critical field Hc2 (4K) > 100T and larger pinning forces Fp (4K) = 1000 GN/m3. Unfortunately, its usage in RF applications is impeded by complicated material growth that requires meticulous stochiometry control and biaxially textured templates, making it virtually impossible to grow REBCO directly on the geometrically complex surfaces required for high-energy physics applications.
In this talk, we present our research achievements over these years [1], where we have worked towards understanding the high-field microwave response of REBCO coated conductors (CCs) and we have demonstrated its better-than Cu RF surface resistance up to fields of 16T. Beyond the vortex physics measurements and understanding at RF fields, high magnetic fields and low temperatures, we will also present our developments on a coating technique using CCs to cover flat and curved surfaces (such as those needed for the beam-screen chamber of the FCC-hh); and our developed hybrid CC / Cu geometries that present lower-than Cu surface resistances at the same time that minimize the trapped magnetic field inside the CC (preserving the homogeneity of the magnetic field in the application's). Our findings have placed CC's technology as a solid candidate to replace Cu as the low surface-impedance coating of the FCC-hh beam-screen. We will also present how our research in CC's microwave response under the extreme conditions found in the FCC [2], together with the large-area CC surface coating technology being developed within the consortium, benefits other areas of high-energy physics such as Axion detection [3].

[1] T. Puig et al, Supercond. Sci. Technol. 32 (2019)
[2] A. Romanov, et al. Scientific reports 10 (2020)
[3] J. Golm, et al. IEEE Trans. App. Supercon. 32 (2022)

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