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Advancing Superconductor Technology for High-Field Applications: Current State and Emerging Trends

Tuesday 23 July 2024 09:45 (45 minutes)

This presentation aims to provide a comprehensive overview of advancements and future directions in superconductor technology, specifically focusing on high field applications. The Low Temperature Superconductors (LTS) Nb-Ti and Nb3Sn continue to dominate the market, with a large demand driven by Magnetic Resonance Imaging (MRI), Nuclear Magnetic Resonance (NMR) spectroscopy and large-scale science projects. In particular, Nb3Sn is the primary candidate for the accelerator magnets in the CERN's Future Circular Collider (FCC), a post-LHC collider targeting proton-proton collision energy in the 100 TeV-range. Achieving this milestone necessitates critical current performance beyond state-of-the-art and eventually close to the material's ultimate limit. On the other hand, High Temperature Superconductors (HTS) are gaining attentions for magnet applications in domains where LTS cannot compete, e.g. for the generation of fields above ˜20 T. This includes user magnets operating at 40 T for high-field science, solenoids up to 60 T to reduce muon emittance in future muon colliders, 30 T magnets for ultra-high-resolution NMR spectrometers and 20 T plasma confinement coils for compact fusion devices. These projects benefit from extensive research efforts in material science that have enhanced the properties of REBa2Cu3O7−x (REBCO, RE = Rare Earth) tapes, especially in extremely high magnetic fields. However, it is important to underscore that high transport properties are not the sole requirement for these prospective applications of LTS and HTS; electromechanical and thermo-physical properties also play a critical role. This presentation offers insights into the close synergetic relationship between evolution of the properties of technical superconductors and advancement in superconducting magnet technology, with a focus on recent research contributions from the University of Geneva (UNIGE).

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