

Irradiation Effects on High-Temperature Superconducting Coated Conductors

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Abstract—High-temperature superconducting (HTS) coated conductors (CCs) are essential for compact fusion magnets, making their radiation tolerance a critical area of research. While most studies focus on 14.1 MeV neutron irradiation, HTS materials are also exposed to other high-energy particles such as electrons, alpha particles, and high energy photons, necessitating a comprehensive assessment of radiation damage tolerance.

In this study, initial studies were conducted by in-operando evaluation of superconducting properties of coated conductors under medium-high x-ray photons (>10 keV) at the ALBA synchrotron for photon fluences up to 10^{19} photons/cm². The transition temperature, T_c and surface resistance, R_s , were evaluated and no damage was observed. Also T_c and the critical current density, J_c , were evaluated with x-ray photons of 3-20 keV, with photon fluences up to 10^{15} photons/cm², and again no deterioration of the material was observed.

On-going studies include investigating the effects of irradiation on HTS films using 2 MeV electron beams from a Van de Graaff accelerator and gamma irradiation from Co-60, both at room temperature, with real-time electrical resistance monitoring. Experiments cover doses below and above 1 MGy to evaluate structural and superconducting property modifications, including defect formation and flux pinning effects. Characterization techniques, in this case, additionally include transmission electron microscopy (TEM) and normal-state charge carrier density (n_H), and samples are REBCO films grown by the transient liquid assisted growth (TLAG) method developed in the group.

Future work will extend this study to in-operando superconducting-state experiments using the same radiation sources, complemented by high-energy hard x-ray photons at the ALBA synchrotron. These efforts aim to provide deeper insights into the dynamic evolution of irradiation-induced defects and their impact on HTS Coated Conductor performance.

Keywords (Index Terms)—Coated Conductors, Critical Current Density, Fusion, Irradiation, RF

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