Highlights

RESEARCH AREA 1 - Superconductors and Innovative materials for Energy and Environment - 2023

High-performance Fe(Se,Te) films on chemical CeO_2-based buffer layers

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The fabrication of a Fe-based coated conductor (CC) becomes possible when Fe(Se,Te) is grown as an epitaxial film on a metallic oriented substrate. Thanks to the material's low structural anisotropy, less strict requirements on the template microstructure allow for the design of a simplified CC architecture with respect to the REBCO multi-layered layout. This design, though, still requires a buffer layer to promote the oriented growth of the superconducting film and avoid diffusion from the metallic template. This paper reports on the deposition and epitaxial growth of Fe(Se,Te) superconducting films with and without seed layer on Zr-doped CeO_2 chemical buffer layers and their detailed characterization. The aim of this study is also to investigate and clarify the role of the seed layer on the final film structural and superconducting properties.
The chemical solution deposition method MOD was successfully employed and the quality of the obtained buffers was assessed via evaluation of structural and microstructural parameters. Deposition of the Fe(Se,Te) film/seed layer was performed via PLD. The epitaxial growth was successful and the optimal structure was retained from the buffer to the top layer. The seed layer not only favours chemical matching with the buffer, indirectly controlling the Se/Te ratio by allowing for low temperature deposition, but it also compensates for buffer layer roughness and protects the Fe(Se,Te) film layer from oxygen contamination. Superconducting properties of a Fe(Se,Te) film were evaluated via dc measurements, and a deeper characterization of the film was carried out via angular measurements. The sample shows a good in-field behavior at all the investigated temperatures, e. g., at 4.2 K the J_c^{18T} is more that 10% J_c^{sf}, with a negligible anisotropy in transport properties visible as a slight difference in J_c values for θ = 0° and θ = 90° (Fig. 1). The anisotropy parameters calculated as $\gamma_H = H_{irr}^{90°}/H_{irr}^{0°}$ is about 1.3 for the whole investigated temperature range with an upturn at high temperature (Fig. 2). For applications at low temperature, thus, the material shows good superconducting properties and low anisotropy, demonstrating the effectiveness and potential of the proposed architecture.

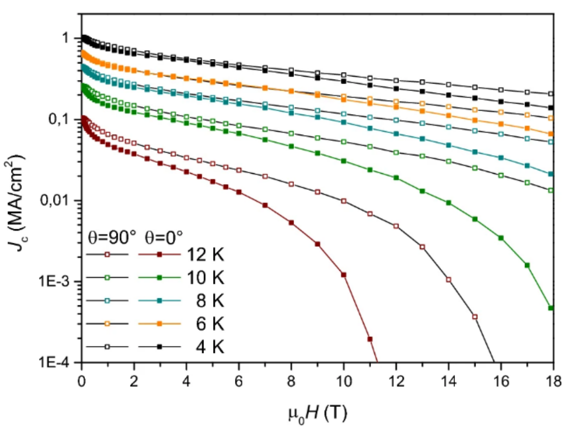

Fig. 1: J_c vs B at different temperatures in a Fe(Se,Te) film deposited on a MOD CZO-buffered YSZ.

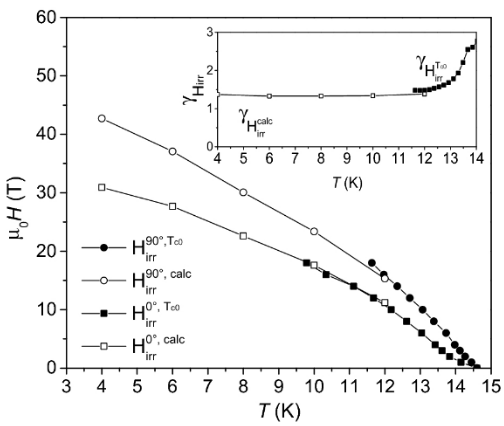

Fig. 2: H_{irr} vs T derived from R vs T measurements (full symbols) and the pinning force fits (empty symbols) in a Fe(Se,Te) film deposited on a MOD CZO-buffered YSZ. Inset: anisotropy of H_{irr}

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