

Enhanced the Critical Current in Nanocrystal-added REBCO Superconductors via He-Ion Irradiation

Ning Zhang^{1,2}, Zhiyong Liu^{1,2}, Rongtie Huang^{1,2}, Difan Zhou^{1,2}, Jing Chen^{1,2}, Yanqun Guo^{1,2},
Li Liu³, and Chuanbing Cai^{1,2}

¹ Shanghai Key Laboratory of High Temperature Superconductors, Shanghai University, China

² Shanghai Creative Superconductor Technologies Co. Ltd., China

³ Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, China

E-mail: ningzhang@shu.edu.cn

Abstract—This study investigates the effects of He-ion irradiation on the in-field performance of nanocrystal-added REBa₂Cu₃O_{7-δ} (REBCO; RE = Y, rare earth element) superconductors at 4.2 K, focusing on the influence of nano-addition concentration on critical current enhancement. Experimental results demonstrate that REBCO with low nanocrystal adding exhibits a 1.68 times increase in the critical current (I_c) at 3 Tesla, while highly added samples show only a 1.18 times improvement, indicating a more pronounced response to irradiation in low-added samples. Additionally, as the irradiation dose increases, the in-field performance enhancement advantages of high-dose irradiation become more apparent, with extrapolated results suggesting greater potential for in-field performance of REBCO improvement under high-dose ion irradiation conditions. This finding reveals the complex interplay between nanocrystal concentration and irradiation dose, providing new insights for optimizing REBCO superconductor performance in high magnetic fields. The results hold significant importance for understanding the synergistic mechanisms between irradiation-induced defects and nanostructures, offering experimental evidence for the development of high-performance superconducting materials.

Keywords (Index Terms)—REBCO; He-ion irradiation; in-field performance; nanocrystal; high magnetic fields