Development of strong vortex pinning and very high $J_c$ in iron based superconductors

CHIARA TARANTINI, National High Magnetic Field Laboratory - Florida State University

Ba(Fe$_{1-x}$Co$_x$)$_2$As$_2$ (Ba122) is the most tunable of the Fe-based superconductors (FBS) in terms of its acceptance of high densities of secondary phases capable of acting as effective pinning centers without depressing the properties of the superconducting matrix. It has been demonstrated that self-assembled nanorods made of Ba-Fe-O generate a strong correlated pinning along the c-axis, enhancing the critical current density, $J_c$, in this direction and reducing the $J_c$ anisotropy [1, 2]. However, when 20% of secondary phases are introduced, the reduction of the cross-section becomes significant, decreasing the low field performance. In order to overcome this issue, artificially introduced pinning centers can be added by multilayer deposition producing an almost isotropic increase of $J_c$ [2]. Moreover, FBS are very sensitive to strain, allowing an important enhancement in the critical temperature, $T_c$, of the material. It will be shown that strain induced by the substrate can further improve $J_c$ of both single and multilayer films by more than expected because of the $T_c$ increase. The multilayer deposition of Ba122 on CaF$_2$ increases the pinning force density, $F_p$, by more than 60% compared to a single layer film, reaching a maximum of 84 GN/m$^3$ at 22.5T and 4.2 K, the highest value ever reported in any 122 phase. This work shows that the in-field performance of Ba122 widely exceeds that of Nb$_3$Sn above 10T, attracting attention for possible applications.

