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

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$Ba(Fe_{1-x}Co_x)_2As_2$ (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_3Sn above 10T, attracting attention for possible applications.

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[2] C. Tarantini, S. Lee, F. Kametani, J. Jiang, J.D. Weiss, J. Jaroszynski, C.M. Folkman, E.E. Hellstrom, C.B. Eom, D.C. Larbalestier, Phys.Rev.B 86, 214504 (2012)

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