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[Invited] Correlated and random pinning behaviors in Sm123 tapes with nanorods

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An introduction of artificial pinning centers (APC) is one of the key techniques to improve a large anisotropy in critical current density J_c $REBa_2Cu_3O_y$ (RE123, RE: Y and rare earth) tapes. The APC technique is utilized in the practical RE123 coated conductors, recently. One of the most promising APCs is a $BaMO_3$ (M; Zr, Sn, Hf, etc) nanorod, which is a nano-scaled columnar-shaped precipitate. However, the effect of nanorod strongly depends on its size and alignment. In the case of the well-aligned nanorod, which is an ideal case as a c-axis correlated pinning center, the matching field limits the F_p behavior and thus the F_p/F_p^{max} curves are scaled against magnetic field below the matching field but are enhanced in high fields above the matching field with decreasing temperature. This can be explained by the cooperation of the random and correlated pinning model. On the other hand, in the case of the inclined nanorod, the scaling behavior of $F_p - B$ curves below the matching field disappears, and the random pinning contribution appears depending on the nanorod' s alignment. On the other hand, the conventional F_p scaling behavior in F_p/F_p^{max} vs B/B_{max} is observed in the Sm123 tapes without APCs. If we compared the angular dependence of J_c between Sm123 tapes with and without APCs, the enhancement of J_c due to the APC for B//c can be seen even at 4.2 K and high fields up to 25 T although the no c-axis peak in angular dependence of J_c. Based on the angular and field dependences of J_c in wide temperatures and high magnetic fields up to 27 T, we discuss the correlated and random pinning effects in the Sm123 tapes with and without nanorods.

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