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## M2Or3B-01 [Invited]: Flux Pinning by BHO Nanoparticles under Various Strength and Orientations of Magnetic Fields in REBCO Coated Conductors Fabricated by UTOC-TFA-MOD Method

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The TFA-MOD method is a powerful way to fabricate  $REBa_2Cu_3O_{7-\delta}$  coated conductors (REBCO-CCs) with high critical current properties with a low fabrication cost. In this study, we focused on the case of  $BaHfO_3$  nanoparticles (BHO-NPs, which have a diameter of  $< 10$  nm) in REBCO-CCs fabricated by the TFA-MOD method with an ultra-thin-once-coating (UTOC) process [1] and carried out critical current density ( $J_c$ ) measurements under wide temperature ( $4.2\text{ K} < T < T_c$ ) and magnetic field ( $B < 24\text{ T}$ ) conditions with various magnetic-field orientations including the longitudinal-magnetic-field (LMF,  $B \parallel J$ ) configuration and the transverse-magnetic-field (TMF,  $B \perp J$ ) configurations.

In the TMF configurations, REBCO with BHO-NPs possessed larger  $J_c(\theta)$  ( $\theta$ : angle between  $B \perp J, \parallel c$  and  $B \perp J, \parallel ab$ ) compared with those in REBCO without BHO-NPs under most of  $T$  and  $B$  conditions, indicating that introduction of BHO-NPs is useful way to improve  $J_c$ . As a characteristic behavior, REBCO with BHO-NPs showed a broad depression of  $J_c(\theta)$  around  $B \parallel ab$  at higher  $T$  and lower  $B$ . We calculated the elementary pinning force based on the model beyond the widely-used model and succeeded in reproducing the depression naturally.

As for the LMF configuration, REBCO with BHO-NPs showed larger  $J_c(B \parallel J)$  than those in REBCO without BHO-NP, suggesting that the flux pinning by BHO-NPs is effective to enhance  $J_c$  in the LMF configuration as well as the TMF configurations.

At the conference, we would like to report the more-detailed data described above and to discuss about them.

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[1] T. Izumi *et al.*, IEEE Trans. Appl. Supercond., **27** (2017) 6601604., K. Nakaoka *et al.*, Supercond. Sci. Technol., **30** (2017) 055008., M. Miura *et al.*, NPG Asia Materials, **9** (2017) e447.

[2] T. Okada *et al.*, IEEE Trans. Appl. Supercond., *in press*.

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