

Remarkable Improvement of In-field Performance in REBCO Coated Conductors

Teruo Izumi^{1,2}, T. Yoshida^{1,2}, A. Ibi^{1,2}, T. Nakamura^{1,2}, K. Kimura^{2,3}, M. Yoshizumi^{1,2},
T. Kato⁴, Y. Shiohara^{1,2}

¹ SRL, International Superconductivity Technology Center, Kawasaki-shi, Kanagawa, Japan.

² Industrial Superconductivity Technology Research Association, Kawasaki-shi, Kanagawa, Japan.

³ SWCC Showa Cable Systems Co. Ltd, Sagamihara-shi, Kanagawa, Japan.

⁴ NRL, Japan Fine Ceramics Center, Nagoya-shi, Aichi, Japan.

Email: izumi@istec.or.jp

Abstract — Through several national projects in Japan, lots of progresses on development of coated conductors have been achieved. In the results, improvement of in-field properties by control of artificial pinning centers was remarkable, which is required from applications in the magnetic fields such as MRI, SMES, rotating machine, accelerator etc.

Concerning PLD films, it was found that the BaHfO₃ nano-rods were more effective to improve in-field performance than the other BMO systems such as BaZrO₃. The BHO nano-rods have thinner diameter and shorter length than those of other BMO. Additionally, the leaning directions of the rods are more random and change of the morphology was not recognized along the film thickness. According to the features of the microstructure, this system showed high J_c(B) values even in thick film and revealed the isotropic behavior in the I_c-B-theta performance. This means that not only I_c@B//c but the minimum I_c(B) value in the angular dependence(I_c(B,min.)) was improved. As a result, the extremely high I_c(B,min.) value of 141A/cm-w at 77K under 3T was realized in a 3.6μm thick film of the short sample by optimization of process conditions in the BHO doped EuBCO system. This performance corresponds to the higher I_c(B,min.) value over 500A/cm-width at 65K under 3T, which is applicable levels for many applications as use in Liq. N₂. Furthermore, the findings were applied for fabrication of long tapes. A 200m long tape with a reasonable I_c(B,min.) value over 54A/cm-width and a 94 m tape with a high I_c(B,min.) value over 108A/cm-width at 77K under 3T were successfully fabricated. The in-field performances in both short and long tapes are world champion results.

On the other hand, it was found that modification of the heat-treatment process is effective to control of the size and the uniform dispersion of BaZrO₃ particles in the YGdBCO films derived by the TFA-MOD process. Especially, the finely dispersed BZO particles could be obtained by the interim annealing. Additionally, the coating process was developed to make thick films with suppression of crack formation, which is necessary to realize the higher in-field I_c property. By combining the above technological progresses, the high in-field I_c value over 50A/cm-width at 77K under 3T was obtained in the 124m long tape.

Keywords (Index Terms) — REBCO coated conductors, PLD and TFA-MOD processing, BHO, BZO and BSO additions as artificial pinning centers (APC), in-field critical currents, M-PACC project