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Enhancement of In-field J_c in GdBa₂Cu₃O_{7-δ} Coated Conductor by Using Highly Oriented IBAD Substrate

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For the improvement of Jc in rare-earth based superconducting coated conductor (CC), it is well established that highly oriented substrate is required because Jc across grain boundaries decreases significantly with increase of grain boundary angles. Typical value of the in-plane misalignment of Ion Beam Assisted Deposition (IBAD) substrate is around 3° where intra-grain Jc is almost the same level of inter-grain Jc at 77K, self-field. However, the effectiveness of highly oriented IBAD substrate on in-field Jc and its temperature dependence have not well clarified yet. In this study, we compared current transport properties in two GdBa₂Cu₃O_{7-δ} CCs deposited on different quality of IBAD templates, i.e., in-plane alignment of the substrate is 1.98° and 2.78°, respectively. From the comparison, Jc enhancement can be confirmed in wide temperature and magnetic field region in the sample using highly oriented IBAD substrate, whereas the irreversibility field doesn't change much. Macroscopic pinning force density curve of these two samples are similar, however, the maximum value of the pinning force density was increased. For the further understanding of the origin of Jc enhancement, we analyzed statistical distribution of Jc from E-J curve by using the percolation transition model. From the analysis, it can be seen that the minimum value of Jc distribution was increased as the substrate texturing is improved. These results indicate that the enhancement of in-field Jc comes from the improvement of grain connectivity. It should be noted that the improvement of in-plane texturing in the substrate is still very effective even in such range of 2 to 3°.

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