Current Limiting Mechanism in Long-Length RE123 Coated Conductor

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We have investigated the origin of local J_c degradation in a 200-m-long commercial RE-123 coated conductor (CC) using reel-to-reel scanning Hall probe microscopy (RTR-SHPM), site-specified measurement by the four-probe method and laser induced thermoelectric (LITE) imaging. RTR-SHPM allows us to detect the position of in-plane J_c degradation in the long length CC tape at 77 K and remanent-field. After characterizing spatial variation of the local J_c, we selected two positions in a high-J_c and low-J_c regions to form two micro-bridges with a size of 100-μm-wide and 500-μm-long, then in-field current transport properties have been studied using four-probe measurements. The transport measurements are consistent with that of RTR-SHPM, i.e., low-J_c bridge has 40 % lower J_c value than that of the high-J_c bridge. Moreover, the magnetic field dependences of J_c are almost the same. Namely, if we compare macroscopic pinning force density, F_p, as a function of magnetic field and temperature, these two bridges show the same scaling behavior with a constant ratio of 1.7, i.e., 40 % smaller F_p in the low-J_c bridge over wide range of temperature (77 K to 4.2 K) and magnetic field (s.f. to 17 T). This result clearly shows that the J_c degradation comes from macroscopic obstacles which reduce effective cross sectional area of the tape whereas nano-structure in the matrix are still fine because the flux pinning properties are not deteriorated even in the low-J_c area. To confirm such microstructural differences, we also carried out LITE imaging using these bridges. We succeeded in visualizing the difference of microstructural disorder in the superconducting layer of these two bridges. The low-J_c bridge has concentrated obstacles with a size of several 10's of μm in each defect while the high-J_c bridge is free from such obstacles as expected. These results suggest that the local J_c degradation is originated from substrate and not from deposition process of the superconducting layer.

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