Study of Local Dissipation in MOD Coated Conductors

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Introduction

To assist technology development process and understand in details electrodynamics of superconducting thin films we study current limiting mechanisms in the $YBa_2Cu_3O_{7-d}$ (YBCO) coated conductors (CC). This requires use of experimental methods which allows mapping both transport and structural properties.

Experimental

We employ recently assembled High Magnetic Field Low Temperature Scanning Laser Microscope to visualize the local electric field distributions (*E*). Insensitive to the magnetic field and noninvasive for the CC finely focused laser beam perturbs current flow in CC via local heating producing electrical response. Local voltage change responses (*dV*) distributions treated as proportional to the *E* maps were taken with resolution about 2-3 μm. To visualize the orientation of grain clusters in YBCO layer we capture and process Electron Backscatter Diffraction Patterns in Scanning Electron Microscope (SEM). Superimposed *E* maps and grain boundary misorientation maps were used to analyze current flow and choose areas of interest, which were later prepared with Focused Ion Beam for cross section high resolution SEM imaging.

Results and Discussion

The maximum *dV* decreases substantially with magnetic field (see Fig.1), because the *E* becomes more homogenous. At low fields the *dV* sharply replicates the GB structure with enhanced values along GBs and on the edges of bottlenecks defined by highly misoriented GB (Fig.1 (a)). At 5T *dV* distribution is considerably different: the largest *dV* amplitude is near the link corners (Fig.1(b)), which means that the *E* inhomogeneities arise mostly from the link geometry. All inhomogeneities in the voltage response map taken at 5T are not elongated in the direction perpendicular to macroscopic current direction, which is in contrast to low field maps.

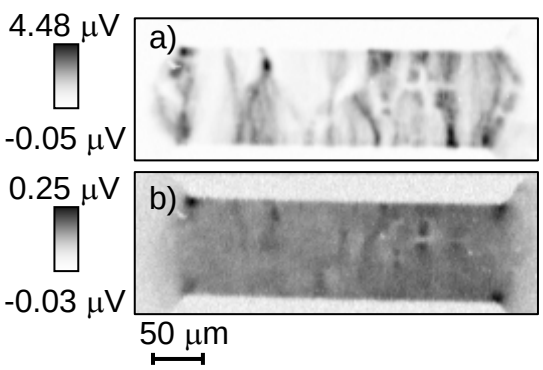

Fig. 1 Voltage responses: (a) selffield, (b) at 5 T.

Detected porosity and secondary phases of 30~35% for current blocking areas create current obstructions as well as high angle GBs, whereas ~20% in current passing areas, which is still much higher than the optimum level of 11% which provides the best pinning properties when the size is optimized.

Conclusions

By visualizing the local electric field distributions we detected the crossover from GB limited current flow regime to bulk limited regime in MOD CC as applied magnetic field varied from 0T to 5T. The interface morphology of the buffer layer is still crucial to cause inhomogeneous current distribution and heavy 2nd phase regions also appear to block current.

Acknowledgements

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References

[1] Abraimov, D., *et al*., Wire Development Group Presentation at DOE Office of Electricity Peer Review (2007).