Significant Reduction of AC Losses in YBCO Patterned Coated Conductors with Transposed Filaments

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Introduction

The reduction of high hysteretic losses in high-T_c YBCO Coated Conductors (CC) tapes remains a very important and challenging problem, because this requires electromagnetic decoupling of filaments, which is usually accomplished by mechanical twisting of round wire multifilament conductors. This method has many crucial drawbacks for the flat CC geometry, so different designs have been proposed recently to emulate the Rutherford tape architecture, in which the filaments can be magnetically decoupled without twisting the conductor.

Experimental

We proposed and implemented for the first time a new conductor design shown in Fig 1 (c), which provides a significant reduction of AC losses without mechanical twisting. The conductor consists of two patterned CCs with electrically insulated slanted filaments thermally bonded face to face through low-resistance bridges in the silver caps. The silver layers of each CC are partly covered by a thin dielectric layer, leaving two parallel uncovered conducting strips which only connect pairs of filaments from each conductor. CCs were patterned with three photolithography stages and wet chemical etchings and then thermally bonded together through resistive Ag bridges so that each filament is electrically connected with only two filaments in the other CC. The electrical conduction paths alternate along the tape in a zigzag pattern, providing complete filament decoupling. Magneto-optical (MO) imaging confirmed the good filament alignment and good YBCO superconducting properties in all bonded samples.

Results and Discussion

AC losses of patterned samples at high fields drop by ≈10 times as compared to losses of the control sample for all frequencies from 10 to 400 Hz. MO images, like the one shown in Fig 1(d), revealed a rather uniform critical state of trapped flux in the filaments imaged through Ni–W substrate. From V-I curves measured for three samples with reduced AC losses, we found that the contact resistance varies in the range 2.4×10^{-8}–1.16×10^{-7} Ωcm^2.

Conclusions

We have implemented a new CC conductor architecture, which provides a significant reduction of ac losses in patterned CCs. The results of this work indicate that further optimization of the bonding process and the reduction of the filament size can produce much more substantial loss reduction.

Acknowledgements

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References

[1] D. Abraimov *et al.*, *Supecond. Sci. Technol.*, **21**, 082004 (2008)

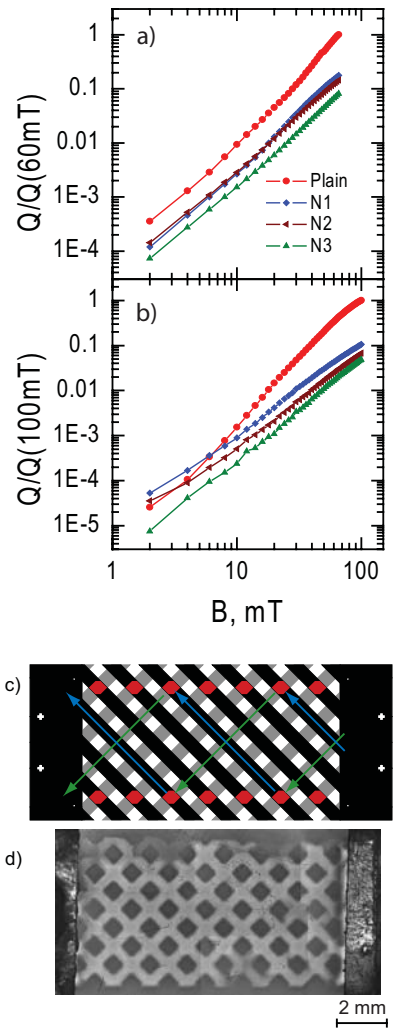

Figure1. Losses for three patterned samples at 400 Hz (a) and 55 Hz (b) normalized to the maximum losses of the controlled sample. (c) Sketch of two bonded CCs where the filaments in the top layer (black) and the bottom layer (gray) are only connected through the resistive silver bridges (red). Alternating current paths are shown with blue and green arrows.
(d) Magneto-optical image of trapped flux in a fully bonded conductor.