Overpressure Processing as the Route to Dense, High Critical Current Density, Coil-Length Bi-2212 Round Wires

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Introduction

Bi-2212 is the only cuprate superconductor that can be made in round wire with high critical current density (J_c), but its magnet use is restricted because gas bubbles form during the reaction, causing wire expansion, leakage and filament dedensification that greatly reduces J_c in coil-length wires compared to short samples with open ends. Here we report that applying total pressures of 10 to 100 bars with a constant oxygen partial pressure of 1 bar during the heat treatment greatly controls the dedensification, eliminates leakage, and hugely raises J_c.

Experimental

Bi-2212 wires with 37 x 18 filaments, 0.8 mm in diameter received a standard heat treatment schedule [1] under pressures ranging from 5 to 100 bars and a constant oxygen partial pressure of 1 bar. The diameter, microstructure and critical current of the fully-processed wires were measured.

Results

We found that 5 bar overpressure (OP) processing limits Bi-2212 wire expansion and prevents leakage, while pressures > 10 bar can densify the wire. As shown in **Figure 1**, the engineering critical current density, J_E (4.2K, 5T), for wires processed at 25 and 50 bar was nearly doubled, compared to short samples with open ends, and increased ~ 7 times compared to closed-ended wire processed under 1 bar. A record J_E (4.2K) of 1064 A/mm^2 at 5 T was achieved in wire processed under 100 bars. **Figure 2** shows that the 100 bar sample has much denser filaments and smaller impurity phases than the 5 bar sample.

Conclusions

Our results provide the essential proof of principle that round-wire Bi-2212 conductors are now ready for serious high-field magnet applications since the densification effect of OP processing is the same for short and long wires with closed ends.

Acknowledgements

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References

[1] Jiang, J, *et al.*, *Supercond. Sci. Technol*, **24**, 082001 (2011).

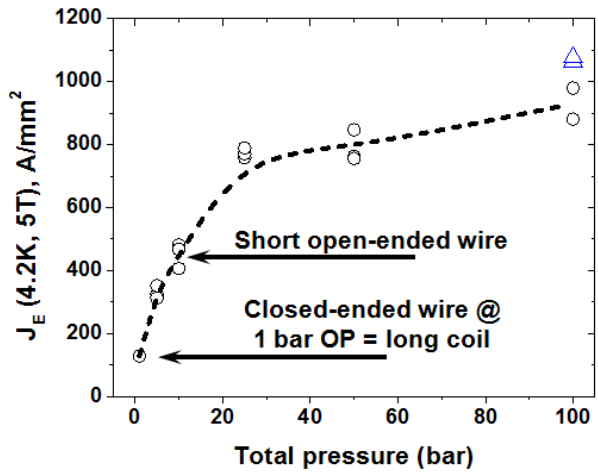

Figure 1: J_E (4.2K, 5T) as a function of total pressure for overpressure processed wires.

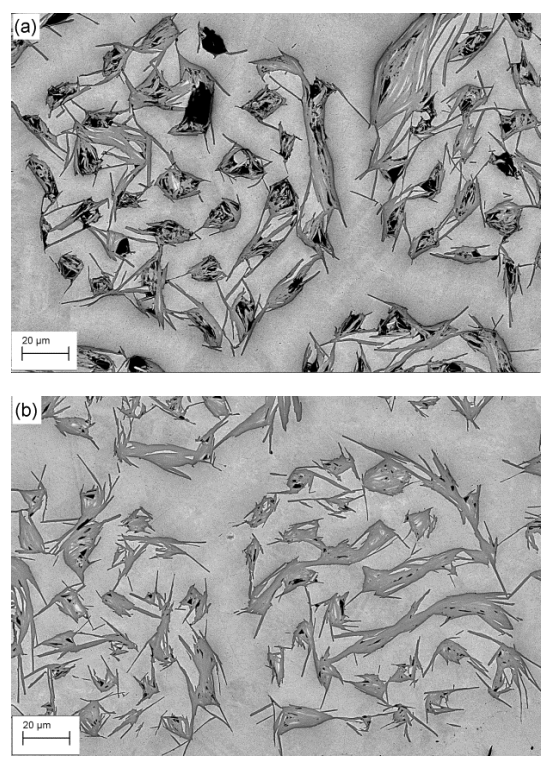

Figure 2: SEM images of Bi-2212 wires processed under (a) 5 bar with I_c (4.2K, 5T) = 177 A, (b) 100 bar with I_c (4.2K,5T) = 463 A.