Overpressure Processing and Evaluating Bi-2212 Round Wires

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Introduction

Our previous work [1] showed that overpressure (OP) processing at 10-100 bar can reduce gas bubbles in the filaments, limit the wire expansion, achieve full densification, prevent leakage, and dramatically increase the critical current density (J_c) in Bi-2212 round wires. We made extensive OP study in 2013 of different Bi-2212 wires procured under Very High Field Superconducting Magnet Collaboration (VHFSMC) from Oxford Superconducting Technology (OST) and Supercon, and wires procured under the DOE Conductor Development Program (CDP). The key goal was to evaluate a broad range of conductors to understand the effects of filament configuration, size and coupling, precursor powder, and carbon content.

Experimental

Bi-2212 wires received a standard heat treatment [1] under an OP pressure of 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

Fig. 1 plots engineering critical current density (J_E) after 100 bar OP processing for VHFSMC wires with the Nexans 521 composition. Wires with the Nexans granulate powder all had a higher J_E than those made with Nexans standard (finer) powder and the SCI powder. The reason for granulate having higher J_c than standard powder is not yet well understood. It is certainly thought by Nexans that the carbon content is lower in granulate than in standard powder. A lower carbon content should lower the internal CO_2 gas pressure in the melt state.

Fig. 2 shows that in the 27x7 wire transport J_c increased by about 40% with decreasing filament diameter (23 to 16 µm). Its SEM micrograph shows little filament bridging after heat treatment. By contrast, the J_c is independent of the filament diameter in the range 11-24 µm diameter in the standard 85x7 and 121x18 architectures. This result is in quite strong contrast to earlier reports by OST on wires heat treated at 1 bar, indicating the need to redo a study of filament size effects in fully-dense filaments.

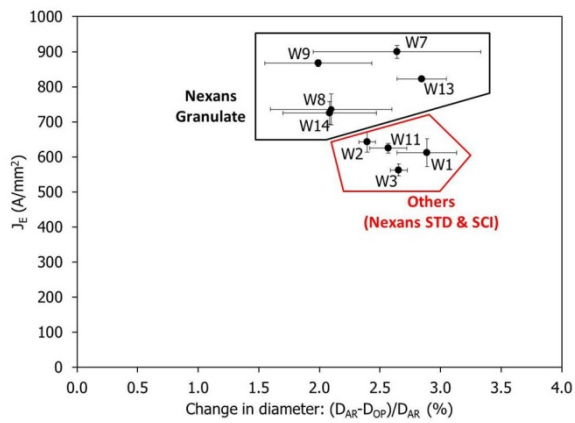

Fig. 1: J_E(4.2K, 5T) for Bi-2212 round wire after 100 bar OP processing. The change in diameter is the % decrease in wire diameter after OP processing.

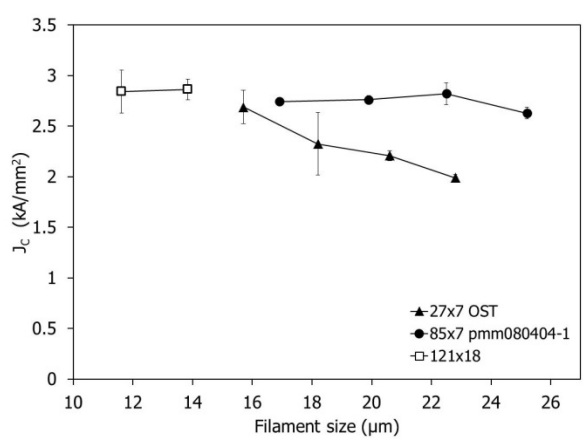

Fig. 2: J_C(4.2K, 5T) as a function of as-drawn filament diameter for wires with different architectures. The 27x7 architecture has a sparse filament distribution with fewer inter-filament connections after heat treatment. The 85x7 and 121x18 wires have the standard architecture which produces extensive filament bridging after heat treatment.

Conclusions

Our work in 2013 has fully confirmed that our previous conclusion of 2012 that eliminating bubbles using OP processing at 10-100 bar is what enables high J_C and J_E in a controllable manner.

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References

[1] Larbalestier D. C., *et al.*, to appear in *Nature Materials*.