**Comparison of a-axis Grain Growth in Multifilamentary Bi-2212 Round Wires with Different Critical Current Densities**

Oloye, T.A., Kametani, F., Matras, M., Jiang, J., Hellstrom, E.E. and Larbalestier, D.C. (NHMFL)

**Introduction**

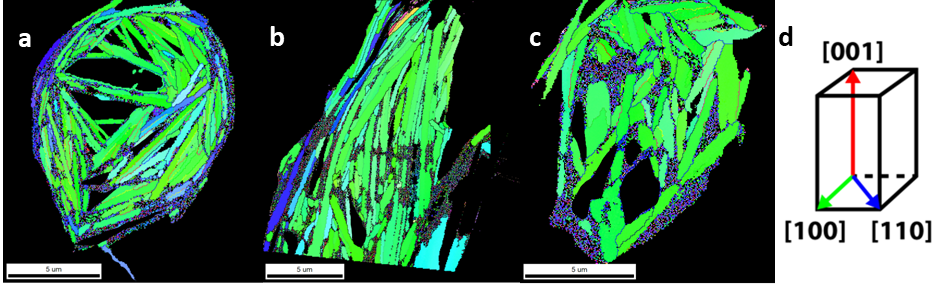
In order to develop high critical current density Jc in long-length high temperature superconducting (HTS) wires, it is necessary to avoid deleterious grain boundaries (GBs). Bi-2212 round wires are unique with regard to the grain texturing that occurs, despite their round wire architectures. In fact a unique grain texture of Bi-2212 is developed by the strong a-axis grain growth along the narrow filament cavities. In the over pressure (OP) heat treatment process, controlling the Bi-2212 a-axis grain growth is the one of key factors for high *J*c. Yet it is not fully understood how the heat treatment parameters, or the quality of precursor powder play roles for such grain texturing.

**Experimental**

In order to evaluate how these parameters affect the Bi-2212 a-axis texture, we compared the transverse cross sections of filaments in three Bi-2212 wires with significantly different Jc values, all heat treated at 50bar over-pressure. Table 1 provides heat treatment parameters and their resulting *J*c values. The two lower *J*c samples (sample a and b, respectively) used the NEXANS precursor powder, while the highest Jc sample used a finer-particle powder from nGimat. These samples were polished in a JEOL Cross Section Polisher (CSP) using an Ar ion beam at 6kV for 6 hours to expose their transverse cross sections. The filament cross sections were then investigated by Electron Backscatter Diffraction-Orientation Imaging Microscopy (EBSD-OIM) in a Carl Zeiss 1540EsB Scanning Electron Microscope.

**Results and Discussion**

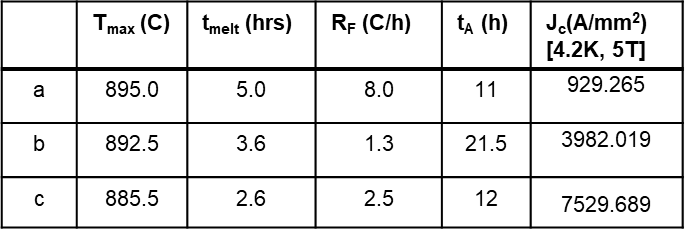
Figure 1 shows the Inverse Pole Figure (IPF) maps of the three Bi-2212 wires a, b and c. Figure 1a and b suggest that a slow cooling rate (RF = 1.3 °C/h) promotes a large 2212 grain size, resulting in ~23% Jc increase in sample (b) compared to fast cooled (RF = 8.0 °C/h) sample (a). Sample (a) also has thinner Bi-2212 grains than the others. In contrast, sample (c) made with nGimat powder developed the highest *J*c (as of Dec. 2017) with grains aligned along the [100] direction. Interestingly these high *Jc* Bi-2212 grains have a similar diameter, but they are twice as thick as those in the lowest *J*c sample (a). Since the highest *Jc* sample uses the new nGimat powder, not the older NEXANS powder, we can directly correlate these microstructural differences to the different heat treatment parameters. Further detailed studies of a-axis growth texture on the longitudinal cross sections will be interesting.



**Fig. 1** Inverse Pole Figure (IPF) maps of 3 bi-2212 wires with different heat treatment parameters and different Jc values. Note that the secondary 2201 phases and Ag phases have been blacked out

**Table I** Heat treatment parameters and Ic values for

Bi-2212 wires used in this study



**Conclusions**

Microstructural analysis of Bi-2212 wires heat treated with different heat treatment parameters or with different powders, suggested that these parameters have a direct bearing on the size and misorientation direction of 2212 grains on the transverse cross section. Future work aims to study the longitudinal cross section of these wires, to enable a clearer picture of how exactly these heat treatment parameters affect grain growth, and subsequently use this information to optimize Ic values.

**Acknowledgements**

A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490 and the State of Florida. The work was supported by the US Department of Energy Physics under DE-SC0010421.