**Optimizing the Milling and Sintering Time to Increase**

***Jc* in K-Doped Ba-122 Superconductor**

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**Introduction**

High intergrain *Jc* (105 Acm-2 at self-field and 104 Acm-2 at 10 T) has been reported in randomly-oriented K-doped BaFe2As2 (K-doped Ba-122) bulks and round wires by our research group [1]. However to be of use in applications, *Jc* must be raised to at least 105 Acm-2 at high fields (10 T – 30 T) [2], [3]. Flat, pressed, and presumably textured, tapes of K-doped Ba-122 [4] and K-doped Sr-122 [5] have reached the application limit at 6 T and 10 T, respectively. Nevertheless, there is limited technological interest in 122 flat tapes due to competition from flat REBCO coated conductors that have much higher *Tc* (~ 90 – 100 K) and *Jc*. Because we have shown that *Jc* is high in round wire, and few HTS materials can be made as round wire, it is important to investigate how to raise *Jc* in round, untextured Ba-122 wires. The high *Jc* reported by Weiss et al. [1] in K-doped Ba-122 bulks and wires is associated with its fine grain size (100-200 nm). In this study, we investigated whether we could optimize the processing to achieve finer grain size, and if this would enhance the vortex pinning and raise *Jc*.

**Experimental**

To change the grain size in bulk, untextured samples, we milled the starting materials for times ranging from 1 to 50 h and HIP sintered the samples for times ranging 0.5 to 10 h at 600 °C at 193 MPa. The samples were characterized using a 14 T superconducting vibrating sample magnetometer, a 9 T superconducting quantum interference device, and an x-ray diffractometer.

**Results and Discussion**

We were able to increase *Jc* by a factor of 1.9 (4.2 K, 10 T) in a sample that was milled for 50 h and then HIP sintered for 0.5 h at 600 °C compared with *Jc* in samples made using our standard synthesis (milled 1 h and HIPped 10 h at 600 °C). Fig. 1b shows the susceptibility for the milled sample is very sharp and that *Tc* decreased slightly in the optimized sample. This small decrease in *Tc* is not significant compared to the almost doubling of *Jc* at 10 T.

**Figure 1.** Comparison between samples made with the standard and our optimized synthesis processes. (a) *Jc* measurements at 4.2 K of K-doped Ba-122 bulks. (b) Magnetic susceptibility plots normalized at 5 K of K-doped Ba-122 bulks showing *Tc* at 10% and 90% of the plot.

In summary, we synthesized K-doped Ba-122 bulks that has almost double *Jc* of the standard sample at 10 T and 4.2 K by increasing the milling time and decreasing the time the sample was sintered, compared to a standard sample. Increasing the milling time (from 1 to 50 h) produced starting powder with a smaller grain size, and reducing the HIP sintering time from 10 h to 0.5 h minimized crystal growth. We attribute the increase of *Jc* at 10 T to the reduction of the grain size that favors pinning the vortices within the grains.

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