NATIONAL HIGH MAGNETIC FIELD LABORATORY

Effect of Time-in-Melt on Filament Merging in 1.0mm Bi-2212 Round Wire

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ABSTRACT

$Bi_2Sr_2CaCu_2O_x$ (Bi-2212) is a high-temperature superconducting compound with a unique property allowing it to be manufactured as a round wire. Sections of wire (4-8 cm) are heated using standard overpressure heat treatment (OP-HT) and quenched, causing crystal growth. A heat-treated sample contains three different shaped bundles. Increased time-in-the-melt results in filament merging within specific bundles in which neighboring filaments bridge together decreasing the performance of the superconductor within the wire. Larger diameter wires allow for more space between filaments which leads to less filament merging and increases supercurrent density. Studying the kinetics of how these filaments merge can allow for better wire architecture and make Bi-2212 more viable in magnet technology.

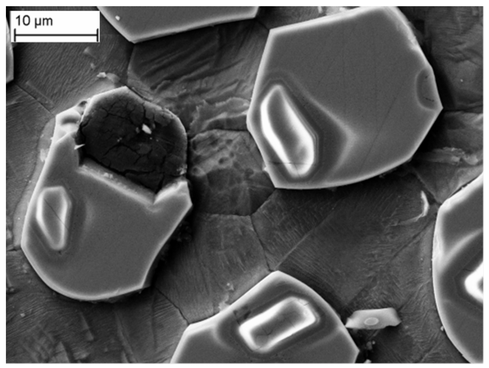

Figure 1: SEM image of Bi-2212 microstructure after being rapidly cooled from the melting stage

PROCEDURE

Bi-2212 1.0mm wire with 85x18 filaments are heated to 888˚C in an overpressure furnace and held at that temperature for varying periods: 1 hour, 2 hours, 4 hours, and 8 hours. The wires are then quenched to room temperature, and 4-8 cm samples are cut and placed in polyfast pucks to analyze the transverse cross-sections. The pucks are ground and polished to remove scratches then examined using two different microscopes: Olympus BX41M-LED Microscope and Scanning Electron Microscope (SEM). Finally, images are captured and the number of filaments per bundle are counted for final analysis.

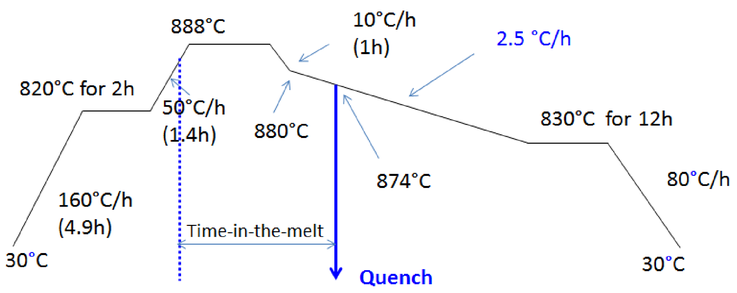

Figure 2: Standard Heat Treatment Procedure

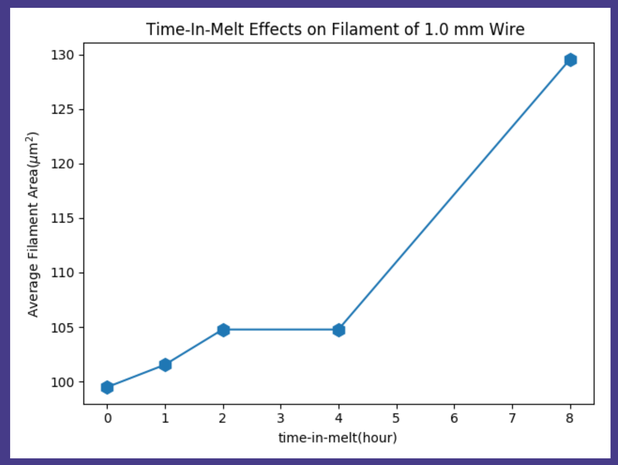

Figure 3: **Filament count decreases over time due to filament merging.**

Longer **time-in-melt increases** filament **merging** within the three different shape bundles in a 1.0 mm **Bi-2212 wire**.

Table 1: **Time-In-Melt effects on filament size and merging. In theory the filament count should 85 x 18 resulting in 1,520 filaments**

Time	Average Filament Area(μm^2)	Average Filament Count
As Defined		1530
PD(0)	99	1526
1	102	1477
2	105	1411
4	104	1290
8	124	1112

RESULTS AND ANALYSIS

As time-in-the melt increased, filament merging also increased. Among the different shapes within the wire, shape three experienced the most filament merging with a filament count that was 200 less than shapes one and two. A plausible explanation for the significant merging of filaments within shape two is the increase of filament density within the bundle. Another interesting thing to note is the 19% increase in filament size between the 4hr and 8hr samples.

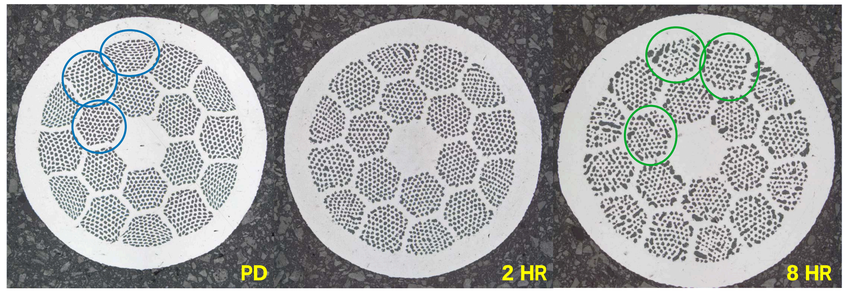

Figure 4: Time-in-the-Melt 1.0 mm diameter Bi-2212 wire.

A comparison of the different shaped bundles within the 1.0mm diameter Bi-2212 wire samples shows an increase in filament merging over longer periods of time. The number of overall filaments decrease due to the filament merging.

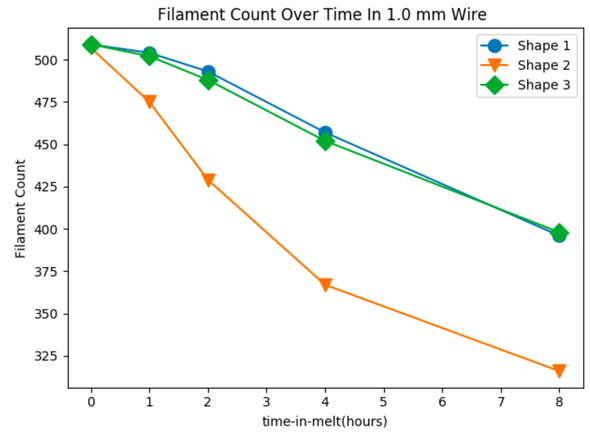

Figure 5: The average filament diameter increases over time due to filament merging.

	Shape 1	Filament Count	Shape 2	Filament Count	Shape 3	Filament Count
PD 830°C/12hrs		85		85		85
8H 888°C/8hrs		67		50		71

Table 2: Bundle shapes and bundle designations

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