Steps Toward an All-Superconducting 30 Tesla Magnet Made from Round Wire

National High Magnetic Field Laboratory

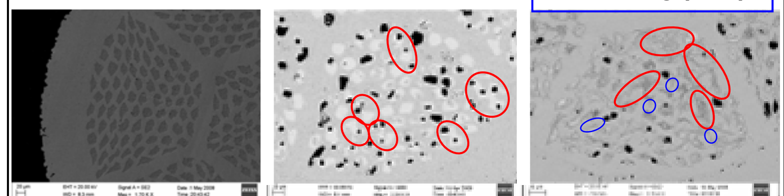
Applied Superconductivity Center, Florida State University

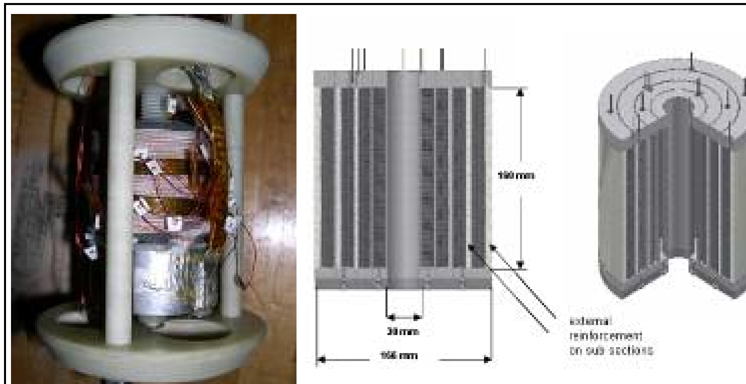
High temperature superconducting cuprates have the capability to pass very high currents in magnetic fields well above the highest DC field in the world, the 45 tesla hybrid magnet (a superconducting outsert of 11 T surrounding a 30 MW resistive copper 34 T magnet) at the NHMFL. A major concern for this unique magnet is that power costs ~$1000/hr and the total bill for supplying high magnetic fields at the NHMFL exceeds $5M per year.

All-superconducting magnets could reduce the cost by millions. In the past year major strides have been made in understanding how to optimize round wires made of Bi-2212. Such round wires offer more versatility for magnets than the tapes of its highly textured competitor YBCO. Indeed it is very surprising that round wires are effective since all other cuprate superconductors rely on texturing to remove grain boundaries that tend to block current flow. Our program is putting such wires into test magnets.

2212 grains form a complicated, interconnected 3-D network that allows good connections even without global texture during heat treatment

As-received wire – homogeneous filaments	Microstructure before 2212 forms – bonded filaments (red)	2212 grains form across bonded filaments (red) and bridge across Ag (blue)





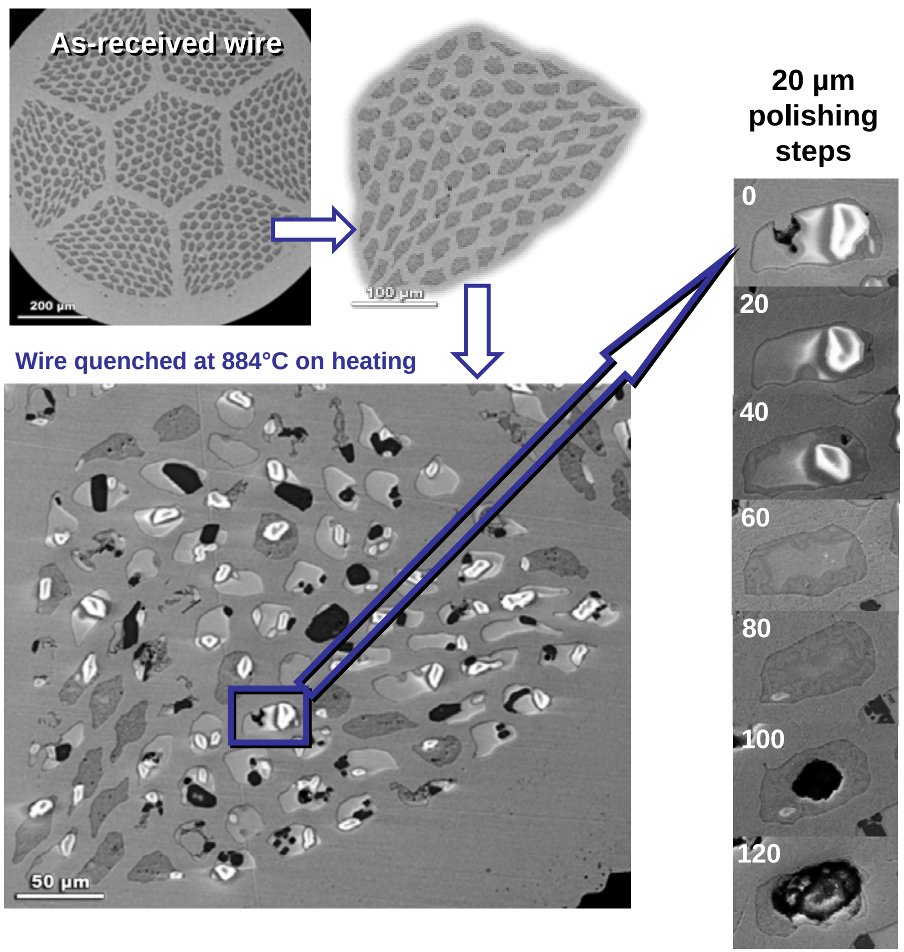
a) fully instrumented test coil (10 layers, 12 turns) set up for in-field transport characterization. b) proposed 7 T insert magnet to be first operated in 20 T background field.

Steps Toward an All-Superconducting 30 Tesla Magnet Made from Round Wire

National High Magnetic Field Laboratory

Applied Superconductivity Center, Florida State University

RET teachers from Ruediger Elementary (Tallahassee, FL) began through-thickness polishing and imaging of 2212 wire. It shows the 3-D nature of filament microstructure that develops during melting. Filaments contain regions of powder, melt, and porosity as melting occurs. Porosity leads to pinch off, which segments the filaments and limits J_c.



Classical superconducting magnet technology has had a hard upper limit of ~22 T for the last 10 years. Present developments at the NHMFL of both YBCO tape and multifilamentary round wire Bi-2212 could enable all-superconducting magnets with fields in the 30 to 50 T range.

The work is being done by NHMFL staff (Ulf Trociewitz and Jianyi Jiang) with graduate students Tengming Shen and David Myers advised by Eric Hellstrom, Justin Schwartz, and David Larbalestier with summer efforts by elementary school teachers (Candace Gautney and Melissa Olson), who have investigated the longitudinal connectivity of the superconducting filaments under the NHMFL's RET program.