Self-monitoring, “SMART” REBCO coated conductors

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Overview
The most important High Temperature Superconductors (HTS) for applications are (RE)Ba2Cu3O7−δ (REBCO) and Bi2Sr2CaCu2O8+δ alloy (Bi2212).

REBCO wires and cables are a very interesting solution for numerous applications. Their current carrying capability at very high magnetic fields allows the generation of the highest fields required in future particle accelerators. The REBCO wires have the advantage of not requiring a post-cooling step at the time of application. The Bi2212 alloy is a promising alternative for high field applications and it is highly mature industrially.

Any superconducting device can be destroyed by an irreversible transition to normal state (quench), unless it’s adequately protected against these events.

Problem: HTS have a slower propagation of normal zones that leads to inefficacy of voltage based quench detection.

Proposed solution: using distributed fiber optic sensors to detect any local transition to normal state before it irreversibly leads to a quench.

Telecommunication grade optical fibers can also be used as sensors of temperature and strain. When they are interrogated by Rayleigh scattering, they offer mm-range spatial resolution and potentially high temporal resolution.

Research Goal
Develop a quench detection system for superconducting devices that is more effective than the currently used voltage based method, particularly for HTS.

Smart REBCO conductor approach
• Another approach to integrate a fiber into a superconducting coil is to design a superconducting wire that already includes it.
• REBCO is the most promising HTS material for applications. It features strengths and performance at high magnetic fields.
• AMSC 2G wire is a perfect fit to realize the smart conductor: optical fibers embedded into the conductor. This process has no reduction in winding packing density.

Co-wound fiber approach
• Different HTS coils fabricated co-winding optical fibers with superconducting wire, with different winding schemes.
• Spectral shift guarantees early detection of normal zones and always anticipates voltage onset (Scurti et al. 2016).

Results
AMSC 2G wire is a perfect fit to realize the smart conductor:
• No reduction in winding packing density
• No need for gratings or expensive fibers
• Integrating optical fibers directly into a 2G HTS wire, the Smart Conductor concept is built on successful work on co-wound fiber approach.

No need for gratings or expensive fibers
Intimate contact between fiber and conductor that leads to inefficacy of voltage based quench detection.

Proposed solution
Builds up on successful work on co-wound optical fibers interrogated by Rayleigh scattering but add:
• Intimate contact between fiber and conductor that leads to highest sensitivity
• No redution in winding packing density
• No change in winding process or magnet design

References