

**2010 Advanced Cables and Conductors Peer Review
Project Summary**

Project Title:	LANL - AMSC Superconductor CRADA for Wire Development
Organization:	Los Alamos National Laboratory
Presenters:	Terry Holesinger (LANL), Yates Coulter (LANL), Doan Nyguen (LANL), Xiaoping Li (AMSC)
FY 2010 Funding:	LANL - \$700 K/ AMSC – \$700 K

Overall Project Purpose and Objectives: The LANL-AMSC CRADA is focused on expanding the materials science base for MOD-YBCO coated conductor technology, identifying the structure-property-processing-chemistry relationships through advanced materials/property characterizations, and developing the necessary understanding to assemble these materials into wires for devices such as cables needed to meet the increasingly demanding needs of the electric power grid. The material science knowledge generated in this CRADA has provided critical information for the development of the RABiTS™ and Metal Organic Deposition (MOD) processes into a performance-leading, low-cost technology for commercial 2G wire addressing electric power applications over a range of cryogenic temperatures and magnet fields. The research program also assists AMSC in establishing practical, low-cost process paths for large volume production of high-performance superconducting wire. LANL works with AMSC on research tasks that address materials and wire issues spanning multiple length scales. LANL also provides AMSC with advanced measurements of AC losses for various wire and cable configurations, providing direction for the design of conductors for electric power grid applications.

Control Milestone

1. Establish key microstructural characteristics of thick MOD-YBCO precursor films required for achieving high I_c in thick single-coat YBCO films (September 2010)

Additional Milestones for FY2010

2. Characterization of thick MOD-YBCO precursor films (including composition, cation segregation, fluoride content and distribution, and residual carbon) (Due July 31, 2010)
3. Correlation of $J_c(H, \Theta, 75K)$ with $J_c(H, \Theta, 30K)$ for 344 superconductors (January 31, 2010)
4. Establish detailed microstructural and property characterization of pinning centers in MOD-YBCO films as function of pinning center additions (September 30, 2010)
5. Establish long-length measurement capabilities for characterizing I_c uniformity of 2G wires and tapes in widths to 46 mm (July 31, 2010).
6. Characterization, measurement and modeling of AC loss in RABiTS-based coated conductors for applications with AC loss measurements and AC loss expertise. (September 30, 2010)
7. Provide written and electronic copies of reports to AMSC documenting our work with AMSC in this subtask. (September 30, 2010)

2010 Approach and Results:

Our approach was to focus the work into two general areas of research, based on the requirements of AMSC and the type of work being performed. Fundamental material science work was performed as part of the Wire Development Group (WDG). WDG work is governed by the need to advance the fundamental material science of epitaxial thick-film growth by chemical solution deposition: understanding growth modes and processes, identifying process(chemistry)-microstructure-property relationships regarding flux pinning in ex-situ grown YBCO films and developing advanced analytical techniques required for characterizing these composite materials. Other work within the CRADA was dictated by AMSC needs in wire manufacturing AC loss measurements and device manufacturing. The dividing line between WDG and core CRADA

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activities is fluid, allowing work in to move between the LANL-AMSC core program and the WDG as necessary to address changes in the needs and status of AMSC R&D and manufacturing activities.

Key results and accomplishments in FY2010 include:

- Development of long-length, non-destructive wire measurements for the identification of wire defects such as drop-outs or anisotropy variations.
- Correlation of in-field wire properties measured at 75K and 26 K.
- Identification of buffer layer properties affecting yield and performance in production wire.
- Identification of precursor structures that affect conversion and performance of thick, single-coat MOD YBCO films.
- Development of a technique and to measure the dependence of magnetic permeability μ_r on internal magnetic field H for the substrate material in RABiTS conductors, which is needed to calculate the current distribution and AC loss in cables.
- Measurement of magnetization loops and hysteresis loss in various substrate structures
- Measured and qualified ac loss and inductance properties of a full-scale FCL coil.
- Measurement and simulation of ac loss and current distribution in cables

2011 Plans and Expectations:

During the coming year, the LANL-AMSC CRADA will continue to focus on examining the fundamental materials science of high temperature superconductors and AC-loss of HTS wires.

Areas of research will include:

- Identifying factors limiting the intrinsic thickness of the single-coat YBCO decomposition-reaction process.
- Characterizing and defining process-microstructure-property relationships of YBCO(MOD) microstructures and in-field critical current.
- Development of advanced characterization techniques for identifying CLM's and insuring quality on 2G wires.
- Advancing the material science understanding of the role of the buffer layer surface chemistry on the epitaxial nucleation and growth of YBCO.
- Non-destructive long length measurements of I_c , and
- Measurement and modeling of AC losses in substrates, wires, and cables.

Specific milestones for each of these will be identified during August and September during the development of our annual operating plan (AOP) based on discussions with DOE program office, AMSC, and results from the peer review process.

Technology Transfer, Collaboration, Partnerships:

The LANL AMSC CRADA is, by its very nature, a close collaboration between LANL and AMSC on wire development and with multiple institutions working collaboratively through the Wire Development Group (WDG) to complete the materials science underlying MOD based YBCO film development. The overall goal is for the development of an HTS wire technology that enables world leadership in HTS wire production by a US company. This partnership allows AMSC to access the expertise of the 2500 scientists and engineers of LANL while allowing LANL participants to interact with the leading scientists from the DOE national laboratories, universities, and IRL (New Zealand). Trimesterly meetings, video conferences, individual visits, emails, phone calls, and inter-organizational sample exchanges insure rapid coordinated progress by exploiting the unique skills at the different laboratories and AMSC.