PROJECT TITLE:	LANL-SuperPower CRADA: Development and Multi-Scale Characterization of IBAD MgO/MOCVD YBCO Coated Conductors
ORGANIZATION:	Los Alamos National Laboratory and SuperPower
PRESENTERS:	Leonardo Civale and Yi-Yuan Xie
FY 2008 FUNDING:	$700K

Overall Project Purpose and Objectives:

The LANL-SuperPower collaboration is focused on advancing the development of high temperature superconductor wires for energy-efficient applications in the US and international marketplace. The technology is based on textured templates produced by ion-beam assisted deposition (IBAD) of bi-axially textured MgO films on high-strength, non-magnetic alloy substrates and the metal-organic chemical vapor deposition (MOCVD) of high-performance YBCO films. The purpose of this CRADA is to provide a fundamental understanding of the properties and microstructures across all relevant length scales of the MOCVD YBCO films and wires produced at SuperPower. It is also the purpose of this CRADA to foster research that continually results in a more robust template technology that will simplify the processing, reduce costs, and increase production yields.

LANL has developed an extensive array of instruments and capabilities for characterizing HTS films and wires across all relevant length scales. LANL has also maintained the expertise and equipment for IBAD research and development. Although the technology has been successfully transferred to SuperPower, LANL continues to target research that will further simplify the IBAD MgO template architecture. We used several techniques, such as TEM, HRTEM, STEM, elemental mapping, SEM and XRD, to determine the structural properties. We developed facilities that allow us to measure nondestructively the position-dependent electrical response (I-V curves) of long lengths of tape at different fields and temperatures. The modular design of our devices provides versatility and unique capabilities such as field-orientation dependence studies of long tapes. These resources were made available to SuperPower to compare and contrast the superconducting properties, general microstructures, and key defect structures of their industry-leading MOCVD / IBAD MgO wires. This work has increased our understanding of SuperPower's state-of-the-art tapes and has identified processing routes that will simply the IBAD MgO architecture and lead to faster processing.

2008 Approach and Results:

The LANL-SuperPower CRADA has focused in the past year on several issues important to the scale-up and path to commercialization of this performance leading technology:

1. At SuperPower's request we electropolished a long portion of their Hastelloy template. The tape was returned to SuperPower for evaluation and further research and development use.

2. Last year at LANL we showed that the architecture of IBAD MgO coated conductors could be simplified by combining the barrier and nucleation layers underneath the IBAD MgO into a single one using Y-Al-O composites, and that YBCO films with good superconducting performance could be deposited on them by PLD. Building on that success, this year we explored the compatibility of this simplified architecture with SuperPower's MOCVD process. At LANL we deposited Y-Al-O composites of several compositions on polished Hastelloy substrates provided by SuperPower. Subsequently all the other layers, including YBCO MOCVD films, were successfully deposited at SuperPower. Samples were then returned to LANL where we characterized them with a variety of structural, transport and magnetization tools.

3. We performed detailed evaluation of several long-length pieces of SuperPower finished wires for various applications. This included position-dependent transport studies of I_c as a function of magnetic field strength and orientation as well as temperature. We also performed higher field studies of selected short pieces aimed at improving our understanding of the microstructural development and correlations to superconducting properties in high-performance MOCVD films.

4. In consultation with SuperPower we designed a long-length characterization tool with the purpose of transferring it to the SuperPower facilities for in-house use. The design is similar to those we currently use at LANL, but specifically customized for their needs and compatibility with their existing capabilities. We fabricated, calibrated and tested the device, which is currently in operating condition.

2009 Plans and Expectations:

In FY 2009 we will continue supporting SuperPower in their scale up efforts. With all the data obtained with our various tools and capabilities, our accumulated knowledge of the structure-chemistry-property relationships in coated conductors, and facilities for IBAD development, we will continue to provide them with information and guidance that will help them optimize wire processing and performance. Where appropriate, we will design, fabricate, and help install property measurement tools as needed.

Specific work plans and expectations:
(1) Continue the analysis of the microstructure and superconducting properties of MOCVD films produced by both research and production equipment.
(2) Optimize the composition and properties of Y-Al-O composites for best results with MOCVD process, and deliver such templates to SuperPower for evaluation and feedback.
(3) Continue position-dependent evaluation of long lengths of tapes and improve the LANL capabilities to respond to the evolving needs of our industrial partner.
(4) Equipment design and delivery.

Technology Transfer, Collaboration, Partnerships:

The LANL-SuperPower CRADA continues to be one of the most successful partnerships in the DOE superconductivity program. Past successes such as the transfer of IBAD YSZ and IBAD MgO technologies from LANL to the SuperPower wire production effort resulted, for instance, in the 2008 *Federal Laboratory Consortium for Technology Transfer Award* for the LANL-SuperPower partnership.

This successful path continues with the current development of simpler IBAD MgO architectures for more robust wires, detailed characterization results that aided the development of SuperPower's performance-leading technology, and position-dependent characterization, both through measurements at LANL and through the transfer of hardware and know-how to SuperPower for in-house characterization.

Results from internal work, open collaborations, and where possible, industry collaboration, are readily published in the open literature for the benefit of the whole HTS community.