PROJECT TITLE:	**Multiscale Characterization of Structure and Properties of Coated Conductors**
ORGANIZATION:	**Los Alamos National Laboratory**
PRESENTERS:	Terry Holesinger and Leonardo Civale
FY 2006 FUNDING:	$ 500K

Project Purpose and FY 2006 Objectives:

High critical current densities (J_c) in YBCO coated conductors depend directly upon the defect types and densities within the films. The various film processes that are employed in U.S. efforts to scale up coated conductors produce different film microstructures, which produce distinctly different pinning behaviors in applied magnetic fields. The challenge for developing a viable wire technology involves, on one hand, the ability to introduce controlled defect structures required for improving the pinning and tailoring the properties in the temperature and magnetic field conditions required for operation and, on the other hand, to maintain those properties across the tape width and over hundreds-of-meter lengths. That is, the coated conductors must contain engineered inhomogeneities on the nanoscale, while being homogeneous on the macroscale. This emphasizes the need for coordinated multiscale structural, chemical and electrical characterization of the tapes. We have started this new project at LANL for the purpose of obtaining a detailed understanding of structure-chemistry-property relationships in coated conductors to aid and guide the development of practical wires for U.S. industry.

FY 2006 Performance and FY 2007 Plans:

To accomplish our goals we have pursued several parallel paths. We integrated our resources with the wire manufacturers and other outside collaborators to compare and contrast superconducting properties and defect structures for different film processes. We used several techniques, such as TEM, HRTEM, elemental spectral maps, 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. We have compared the results with those obtained by static methods on short samples. We applied these tools and knowledge to characterize state-of-the-art tapes and to troubleshoot scale up problems and provide feedback to our industrial partners. Simultaneously, we produced our own high quality PLD films with carefully designed defect structures.

In FY 2007 we will continue supporting our industrial collaborators in their scale up efforts. Based on the data obtained with our various tools and our accumulated knowledge of the structure-chemistry-property relationships in coated conductors, we will provide our collaborators with information and guide that will help them to optimize their wires. As needed, we will continue using our tools to troubleshoot problems in the scale up process. We will work with industry to improve our long-length characterization tools and adapt them to their evolving needs. On the other hand, the CC technology is reaching the level where we must be ready to switch from *characterization* of tapes to *qualification* of commercial products. To that end, in consultation with our partners, we will determine what is the minimum set of properties that must be monitored as part of a production line. We will also continue designing, fabricating and installing property measurement tools for our industrial partners.

Our FY 2007 plans also include producing YBCO films on tapes with controlled defect structures using PLD and sectored targets. We will design and demonstrate CC with flux pinning tuned for specific operation conditions.

FY 2006 Results:

- Helped AMSC understand the MOD film development process.
- Clearly identified and correlated pinning structures in MOD films with superconducting properties.
- Continued to transfer IBAD MgO technology to SuperPower.
- Investigated and solved specific production line problems for both AMSC and SuperPower
- Provided detailed structural and electrical characterization of champion SuperPower and AMSC tapes.
- Developed and demonstrated the usefulness of novel and versatile measurement apparatuses for long length

wire characterization.
- Developed unique capabilities to perform continuous measurements of I_c at different temperatures, field strengths and orientations.
- Produced ultrafine multilayer structures in a moving tape for large-scale applications.

Research Integration: LANL has maintained close collaborative ties with key industrial, academic, and national laboratory partners for the purpose of accelerating HTS wire development. With regard to industry, LANL provided significant help to American Superconductor, SuperPower, MetOx, and Oxford Superconducting Technology with their respective processes for wire development. In the past year, LANL personnel have traveled to SuperPower to transfer their knowledge of the IBAD MgO process. The result was the attainment of record HTS wire values by SuperPower using the IBAD MgO process in under 6 months time. LANL was also instrumental in the past year at trouble-shooting production problems at SuperPower and American Superconductor through the use of key characterization tools available at LANL. Collaborations also exist with other national laboratories (Argonne, Brookhaven, Oak Ridge, and Sandia), universities (Stanford, Wisconsin, others), and industry-led research teams, such as the Wire Development Group, for the purpose of understanding the properties of these HTS wires. 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.