Project Title:	Los Alamos Coated Conductor Development
Organization(s):	**Los Alamos National Laboratory**
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FY 2004 Funding:	$2,100 K

Project Purpose and FY 2004 Objectives: This part of the Los Alamos coated conductor development program is intended to accelerate the development, commercialization, and application of $YBa_2Cu_3O_y$ (YBCO) high temperature superconductors. Three focus areas are: internal scale up of the coated conductor (CC) fabrication processes based on IBAD MgO up to 10 meter lengths, development of new processes more suitable for manufacturing, and targeted collaborative R&D with US industry for development and characterization of long-length coated conductors. Specific objectives for FY 2004 under the CC development program were:

- Finish a modestly scaled CC fabrication (5-10 m) and characterization facility
  a) Produce lengths of over 5 meters with more than 200 A per cm-width;
  b) Produce 1 meter lengths of CC with less than 10% I_c variation;
  c) Demonstrate IBAD template repair with measurable I_c across repaired regions;
  d) Utilize ion scattering *in situ* diagnostics for diffusion barrier optimization;
  e) Implement YBCO reactive coevaporation
- Further collaborative relationships with industrial partners for the purpose of advancing the state of CC development and its commercialization in the U.S.
  a) Provide longer lengths (up to 10m) of IBAD-MgO templates to our industrial collaborators with in plane texture less than 8°.
  b) Provide access to facilities for targeted collaborative research in characterizing CC samples.

FY 2004 Performance and FY2005 Plans: The reel-to-reel systems at the Los Alamos Research Park are now producing CC's at a level of performance comparable to short length samples prepared in our Core Program. Electropolishing has produced several kilometers of smooth tape (2 and 4-mil tape) for internal IBAD MgO deposition and external development at our industrial partners. The ion beam assisted deposition (IBAD) system has produced 0.5 kilometer of IBAD-MgO with epitaxial MgO on top, in piece-lengths up to 10 meters. The in-plane texture is in the range of 6° – 8° full-width half maximum (FWHM). Ion scattering analytical equipment has been installed in the IBAD system for *in situ* surface analysis. This surface diagnostic tool has been used to optimize our Al_2O_3 diffusion barrier to be able to withstand temperatures above 900 °C without failure. A modified target rastering mechanism was installed in the pulsed laser deposition (PLD) system and has resulted in dramatically improved plume stability and resulting tape uniformity. In addition, a new continuous tape heater was installed that contains 9 separately controlled heating zones for optimal control of the temperature profile through the deposition zone. Fully processed CC's with over 200 A performance are now routinely obtained. Buffered and HTS-coated tapes have been provided to our collaborators. A deposition system for reactive coevaporation of YBCO on tapes is currently being installed. A system capable of measuring the local I_c's (length scales of 1-10 cm) in lengths of up to 100 m of HTS coated conductor was finished and used to characterize several long tapes (10 m) from our industrial partners.

For FY2005, we plan to further demonstrate the promise of coated conductors by obtaining transport currents in excess of 500 A/cm-width in lengths of over 1 meter. This is to be accomplished by improving the reproducibility and uniformity of the processes and incorporating the advances of the LANL Core program into the continuous processing of IBAD MgO coated conductors. Short lengths of coated conductors with J_c values in excess of $1MA/cm^2$ will be also made by the reactive coevaporation of YBCO, which has great promise for low-cost and high-rate deposition. Up to 100 m piece lengths of HTS coated conductor from our industrial partners will be measured for positional I_c.

FY 2004 Results: In FY2004, significant results have been obtained in the areas of electropolishing, IBAD-MgO, PLD, electrodeposition of stabilizing layers, and continuous I_c measurements of long length coated conductors.:

- Modifications to the electropolishing system currently allow for polishing of substrates up to 3 cm wide. Polishing of RABiTS templates was also initiated at the request of an industrial partner. A new system was installed for short length polishing with the goal of faster experimentation with a number of electrolytes.
- IBAD-MgO process speeds of over 100 meters/hour in a 10-cm deposition zone (laboratory scale) have been demonstrated.
- PLD buffer layer deposition has been demonstrated on several longer (> 5 m) lengths. Some of these buffered tapes have been supplied to our collaborators in industry, national labs and universities for development of their HTS processes. YBCO deposited continuously by PLD has shown in-plane FWHM values on the order of 2.8° - 3.5°, with I_c's > 200 A. Our best tapes have a uniformity on a 1-cm scale of ~ ± 4.5% in I_c for 20 cm long pieces, and ±7.8% over 1 meter.
- We have electroplated copper on our coated conductors to thermally stabilize the conductor and improve its mechanical robustness, without degrading its I_c. With the copper plating we are able to apply a current equal to 2.5 times the I_c of the tape.
- We have characterized numerous coated conductors from our industrial partners for positional I_c dependence (up to 10 meters long) and angular magnetic field dependence.

Technology Integration: On-going development of processes is responsive to the needs of CRADA collaborations and user facility operations. Central to this development is the expectation of free exchange of information and materials among the DOE laboratories and CRADA partners. At least half a dozen visits by and to our industry partners have been arranged in the past year. These have led to information and sample exchange. Tens of meters of coated tape have been sent to our partners. We have sample exchange with American Superconductor, MetOx, SuperPower, Oak Ridge National Lab, Sandia National Lab, Stanford University, and University of Wisconsin.