Project Title:	Los Alamos Research Park Coated Conductor Development
Organization(s):	**Los Alamos National Laboratory**
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FY 2003 Funding:	$1,500 K

Project Purpose and FY 2003 Objectives: The purpose of the Los Alamos Research Park coated conductor facility is to accelerate the development, commercialization, and application of high temperature superconductors. This is done through scale up of the coated conductor (CC) fabrication processes and increased collaborations among DOE laboratories, American industry, and universities. Our primary objectives for FY 2003 under the accelerated CC development program were:

- To demonstrate capability of CC preparation and characterization for:
  a) Producing long lengths of smooth metal tape by electropolishing;
  b) Producing lengths of ion-beam assisted deposited (IBAD) MgO textured layers on the smooth metal tape, with in-plane texture better than 8° FWHM;
  c) Producing superconducting and oxide buffer layers continuously by pulsed laser deposition (PLD) on IBAD templates;
  d) Characterizing the positional dependence of critical current in meter lengths of CC by low-temperature electrical measurements;
  e) And to introduce more *in situ* diagnostics capabilities for process monitoring.
- To further collaborative relationships with external partners, esp. industry, for the purpose of jointly advancing the state of CC development and its commercialization.

FY 2003 Performance and FY2004 Plans: In FY2003 we have been operating all the CC processes in a reel-to-reel mode. This has allowed us to do high-throughput experimentation. The new systems at the Research Park are now producing materials at a similar level of performance as our core program. Continuous electropolishing has produced kilometers of smooth tape ready for IBAD deposition. A significant amount of this polished tape was also provided to our partners for their R&D. The IBAD system has produced long lengths (total of over 100 meters) of IBAD-MgO with epitaxial MgO on top, with a number of pieces longer than 5 meters. The in-plane texture for the better runs is in the range of 5° – 8° full width half maximum (FWHM). Procurement of the ion scattering equipment for surface analysis in this system has been initiated, but due to budget delays we are not able to install the equipment in this fiscal year. The PLD system is producing buffer layers and YBCO on continuously moving tape, as well. This buffered and HTS-coated tape has also been provided to our collaborators. In short pieces we have demonstrated over 70 A performance. In the past year we have had a number of productive collaborations with industry, national lab and university partners. Industrial partners, in particular, have had multiple site visits leading to substantive collaborations.

For FY2004, we plan to improve reproducibility and uniformity of our processes and to bring the coated conductor performance to longer lengths. We will complete implementation of ion scattering to our vacuum processes, and we will bring other *in situ* tools to aid process development. For the PLD system, we will implement a newly designed and purchased continuous tape heater which will allow us to go to higher deposition rates for our HTS layers. We will also bring in a new process for HTS deposition, namely reactive coevaporation, which has great promise for low cost and high rate deposition of YBCO. As we continue to demonstrate improved performance of our materials, we plan to have more partners come to the Los Alamos Research Park to work together on CC development.

FY 2003 Results: In FY2003 the scaled-up equipment in each of the new labs has been used extensively.

Our tape finishing unit for cleaning and polishing has been further improved in the past year. Original contacts employed brushes touching the tape surface which produced some scratches. We have converted the electrolytic cell to a contactless bipolar arrangement where no mechanical contact is made to the tape

during the electropolishing process. This has led to better quality tape, ie with no scratches and even less roughness. Typical results yield 0.5 nm RMS roughness on 5 x 5 micrometer areas. Hundreds of meters of electropolished tape have been provided to our partners.

1. Our IBAD-MgO process has been studied in more detail to understand the limits of the texture we can attain. We have measured and optimized the ion beam divergence and reduced it to half the original value as obtained from the manufacturer. We also studied the effect of ion-to-atom ratios in more detail, as well as other relevant parameters. All of this has contributed to a systematic improvement of the in-plane texture for our IBAD templates. *In situ* RHEED has been key to this optimization process. Last year we obtained 12° in-plane FWHM for our MgO texture and we have steadily improved on that. We have also tried to establish the limits of this process under current conditions, which we estimate to be roughly 3° in-plane texture for the MgO. Typical good results on our continuously moving Hastelloy tape are 5° - 8° in-plane FWHM. We have made a number of longer length pieces of IBAD tape, including lengths over 5 meters.
2. Our PLD process has been fully implemented and is producing buffer materials and YBCO on continuously moving tape. We have chosen $LaMnO_3$ (LMO) as a buffer material due to its high deposition rate and low deposition temperature. At this point, we are able to produce LMO buffered tape at up to 21 m/hr. We have demonstrated this on several longer (> 3 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. Our YBCO deposition process has resulted in excellent texture and good Ic tapes as well.
3. The low-temperature transport measurement apparatus for continuous measurements of long lengths of tape has been used for characterizing materials. A new, second generation, apparatus with improved capabilities and faster sample turnaround has been designed and built. This apparatus is capable of measuring positional dependence of Ic in coated conductors over 100 meter lengths.

Research Integration: On-going development of processes is responsive to the needs of CRADA collaborations and user facility operations. Major partner interactions have started to take shape in the past year, especially with our major industrial partner SuperPower. At least half a dozen site visits by industry partners have been arranged in the past year. These have led to information and sample exchange. Hundreds of meters of polished metal tape and meters of coated tape have been sent to our partners. We are also pursuing several university collaborations, including *in situ* PLD plume monitoring with the Air Force Institute of Technology.