Project Title:	**Coated Conductor Template Research**
Organization:	Los Alamos National Laboratory
Presenters:	Vladimir Matias and Liliana Stan
FY 2010 Funding:	$600 K (IBAD R&D) + $450 K (Template R&D)

Overall Project Purpose and Objectives:

LANL has been at the forefront of developing CC templates based on IBAD texturing technology. In order to continue our research in this area we have developed unique capabilities to simultaneously explore the IBAD related processes and applicability of IBAD, as well as to fabricate long lengths of tape using these processes.

The overall goal in our IBAD template research is to achieve a template that is highly aligned and physically robust at high temperatures for epitaxial growth of HTS layers. The relevant processes need to be robust and inexpensive for long-length manufacturing of coated conductors. We seek to accomplish these goals by understanding the fundamental issues in the performance of the template and the relevant materials science. Our approach is to demonstrate the practicality of the various textured templates by demonstrating the quality of HTS layer performance.

Key objectives that we are currently addressing in the IBAD template research are:

- Understanding the fundamental mechanisms and applicability of ion-beam induced texturing of thin films;
- Reducing the cost of the substrate by developing substrate finishing processes to utilize inexpensive metal alloys;
- Simplifying the textured template architecture and thereby reducing manufacturing cost;
- Enhancing the variety of textured template geometries with the goal of enhancing performance in the coated conductor, esp. increasing the engineering critical current density and reducing ac-losses.

2010 Approach and Results:

In this year we have continued to investigate substrate preparation, IBAD texturing, and template architecture to address the key issues stated above. Electropolishing of substrates is deemed too restrictive in the type of alloys that can be used, as well as environmentally unfriendly. Alternative methods of smooth substrate preparation were explored with solution deposition planarization (SDP) using both a conventional sol-gel approach and polymer assisted deposition. Our Stanford University collaborators are studying IBAD texturing using *in situ* quartz crystal monitoring, *ex situ* synchrotron radiation diffraction and TEM to determine initial stages of film growth. We also focused on reducing the complexity of CC fabrication by simplifying the template architecture and using high yield processes.

Specific results and accomplishments in FY2010 include:

- Further developed the model for IBAD-MgO film texturing at nucleation based on the scientific research performed at LANL and Stanford University; explored in detail the role of ion beam divergence and ion-to-atom ratios (IAR) during the texturing process; clarified differences in the two regimes of high and low IAR values
- Continued research on solution deposition planarization (SDP) for substrate preparation for IBAD with a significant breakthrough by achieving surface roughness as low as 0.5 nm RMS on a 5x5 μm area; developed a model for roughness reduction; developed SDP on stainless steel substrates

- Built a deposition system for long-length (100 meters) and wide web (10-cm) SDP processing; enables us to supply sufficient quantity of substrate for internal needs and those of our industrial partners
- Implemented the polymer assisted deposition (PAD) technique for the deposition of Y-Al-O; achieved over 200A/cm (75.5K, self field) on a coated conductor with simplified 3-layer architecture including PAD YAlO.
- Investigated the PAD technique as a method of planarization of the metal substrates
- Continued research on the two-layer architecture based on IBAD TiN template

2011 Plans and Expectations:

For FY2011 we plan to work in the following areas: a) research the science of IBAD and the applicability of IBAD texturing to a variety of relevant materials; b) research texture formation on round surfaces; c) continue to improve the SDP process for coated conductors and further develop PAD for this purpose.

In IBAD research we want to continue to significantly enhance our understanding of the role of the nucleation step during IBAD texturing, and explore applicability of IBAD texturing to a variety of crystal structures. In this area we intend to use the experimental techniques that are available to us at LANL as well as work together with Stanford University.

We will continue working on exploration of new textured templates and growth of HTS films in different geometries that could be applicable for coated conductors with higher performance, in terms of engineering critical current densities and lower ac losses.

Technology Transfer, Collaboration, Partnerships:

This project involves three CRADA partnerships, all of which are potential producers of HTS wire: SuperPower, Metal Oxide Technologies Inc. (MetOx) and Superconductor Technologies Inc. (STI). We have ongoing sample exchange collaborations with all three of these companies in which we provide them with long lengths of electropolished substrate tape, solution-deposition planarized metal tapes with an IBAD template for their evaluation.

We collaborate extensively with Paul Clem at Sandia National Laboratories on solution deposition planarization for IBAD application and we have had several exchange visits. Paul Clem and his team are assisting us in development of new materials to be used in solution deposition. We also collaborated with Parans Paranthaman from ORNL to develop IBAD MgO template for coated conductors.

We work together with Prof. Bruce Clemens and Dr. Robert Hammond at Stanford University on IBAD texturing and in this year. Randy Groves, on leave from our group, has gone to Stanford University as a graduate student to work on the science and applications of IBAD texturing.

The research performed in this project has resulted in 5 technical papers and 6 conference presentations (one invited talk) for this year. We also had an R&D 100 Award Entry for 2010.