Project Title:	**Progress in Reactive Co-Evaporation on IBAD; LANL/STI CRADA**
Organization:	Los Alamos National Laboratory
Presenters:	Vladimir Matias (LANL) and Brian Moeckly (STI)
FY 2010 Funding:	$150K (RCE R&D) + $250K (LANL/STI CRADA)

Overall Project Purpose and Objectives:

The overall goal of the Reactive Co-evaporation (RCE) project for HTS layers is to develop and demonstrate a low-cost, scalable, and high-performance method for coated conductor manufacturing. LANL and STI are working as partners in this project and have a joint CRADA on this topic. The technology is based on IBAD-textured templates using high-strength, non-magnetic metal substrates and RCE of highly-aligned and engineered YBCO films. It is the purpose of this research to continually develop a more robust, manufacturable template technology that will simplify processing and reduce cost, while improving performance. Furthermore, advances are expected in HTS films to engineer the conductor in order to optimize high current performance in a magnetic field and in applied ac fields.

Key objectives that we are currently addressing in the project are:

- Understanding the performance and throughput limits of the cyclic deposition reaction approach to RCE of HTS materials
- Optimizing the IBAD-aligned template in terms of the best performance and lowest cost required for RCE
- Optimizing the HTS layers by RCE for highest critical currents in a magnetic field

2010 Approach and Results:

The LANL-STI collaboration combines the expertise at LANL in IBAD and RCE with extensive process development and manufacturing experience at STI using the RCE process for HTS materials. Our combined capabilities allow us to explore new coated conductor architectures relatively quickly and continuously improve our processes. We continued our collaboration in FY2010 in terms of ongoing sample exchange and characterization of STI samples at LANL.

In this year we obtained excellent results on YBCO films that were deposited by RCE directly and epitaxially on the textured MgO layer. We are also currently utilizing the solution deposition planarization (SDP) process for substrate preparation as a way to reduce the cost of the substrate and simplify the architecture even further.

Specific results and accomplishments of this project in FY2010 include:

- Achieved over 4 MA/cm^2 (LN2, self field) in an RCE-deposited YBCO on an MgO template with the simplified architecture using SDP.
- Expansion of our CRADA with a new Project Task Statement between LANL and STI that includes a funds-in portion as well as the DOE-funded part
- We have examined stacks of YBCO layers using alternating SDP/IBAD/RCE layer structures as a promising way to achieve high critical currents
- STI are optimizing their HTS layer performance using second phase dopants and rare-earth element substitution in RCE

We have continued to refine our RCE cost model based on our current understanding of the RCE process. STI have also performed an independent cost analysis of the RCE process for coated conductors. The cost of HTS deposition in a high volume exceeding 10,000 km/year is estimated to be about $4/kA•m. We believe that there are further possibilities for cost reductions based on better utilization of materials, and by increasing J_c and J_e of the HTS films.

2011 Plans and Expectations:

For FY2011 we expect to work in two main areas: a) continuing to make progress on STI's short samples to explore the performance limits of RCE and b) support STI in their effort to scale up production and make 10+ meter long coated conductors and for STI to introduce IBAD and SDP technologies.

There is still plenty of room at the top to go in terms of better performance for coated conductors as well as reduce cost. We plan to work on several topics that share the ultimate goal of achieving coated conductors at a cost of less than $10/kAm.

Technology Transfer, Collaboration, Partnerships:

LANL has entered into a new CRADA with Superconductor Technologies, Inc. in Santa Barbara, CA, in late 2008. In 2010 we signed a new Project Task Statement that includes a funds in portion to LANL in order to facilitate a greater supply of IBAD templates that STI needs for their scaled up production. LANL provides STI with templates, process know-how, as well as measurements of STI samples.

We collaborate with Robert Hammond and his group at Stanford University on YBCO deposition technologies. We also collaborate with Paul Clem and his team at Sandia National Labs on solution deposition for substrate preparation.

The research performed in this project has resulted in one published invited technical paper, three technical papers in preparation, and five conference presentations.