Project Title:	**ORNL-SuperPower CRADA: Development of MOCVD-based, IBAD- 2G Wires**
Organization:	Oak Ridge National Laboratory/ SuperPower/ University of Houston
Presenters:	Tolga Aytug, M. Parans Paranthaman, Amit Goyal (ORNL), and Venkat Selvamanickam (SuperPower/University of Houston)
FY 2010 Funding:	$800 K (DOE to ORNL)

Overall Project Purpose and Objectives:

The overall objective of this project is to assist SuperPower in the development of high performance IBAD-MOCVD-based 2G wires for the commercial application of HTS technology. The approach is to carry out R&D support to achieve an improved understanding of the fundamental properties of the IBAD-MgO templates as well as MOCVD-REBCO to enable manufacturing of robust & high performance 2G wires. This understanding is critical to the development of a reliable, long-length manufacturing process based on MOCVD-REBCO/LMO/IBAD-MgO/Hastelloy wires. This project directly impacts the DOE-OE subprogram goal of: (1) developing prototype wire achieving 1,000,000 length-critical current (A-m) for second generation wire, and (2) produce high temperature superconducting coil that operates in applied magnetic fields up to 5 Tesla at 65 K for HTS applications.

FY 2010 Plans were:

1. Continue ORNL assistance to SuperPower for fabricating long-length, robust IBAD-MgO/LMO/MOCVD-REBCO with improved flux pinning properties in pilot-scale production level.
2. Continue development of simplified buffer architectures leading to improved template performance and/or reduced manufacturing cost.
3. Develop dip-coating conditions to growth nanocrystalline buffers and demonstrate the growth of robust buffers and superconductor films.
4. Continue optimization of pinning mechanisms and microstructure-processing-property correlations in thick REBCO films produced in manufacturing.
5. Further investigate the efficacy of pinning enhancement in MOCVD REBCO via artificial pinning centers.
6. Transfer the knowledge learned from the MOCVD system regarding growth of REBCO films located at ORNL to SuperPower.

2010 Approach and Results:

The SuperPower/ORNL High Performance LMO-enabled, High Temperature Superconducting Tape (LMO e-HTS) is a robust, high-current second-generation superconducting wire. This superconducting wire can be fabricated at high throughput rates using reel-to-reel processes. One of the key success factors which have enabled the above is the use of an epitaxial $LaMnO_3$ (LMO) buffer layer which can be deposited at high rates homogenously in long lengths. This buffer layer also allows formation of very high performance superconducting films. SuperPower demonstrated world-record performance superconducting wires based on the ORNL-developed LMO platform. To optimize the pinning performance of HTS films on such substrates, incorporation of double perovskite based columnar defects were investigated.

Specific key results and accomplishments in FY2010 include:

- Demonstrated high growth rates of Zr-incorporated HTS wires at SuperPower/University of Houston in the pre-pilot system with improved pinning through rare earth optimization
- Performed detailed phase, structural and microstructural analysis of MOCVD (Y,Gd)BCO films with Zr additions made at SuperPower as a function of deposition temperature and composition.
- Performed detailed superconducting property measurements of (Y,Gd)BCO films with Zr additions made at SuperPower in a broad temperature-field regime and correlated with the phase, texture and microstructure.
- Successfully incorporated double perovskite based columnar defects in MOCVD-YBCO films for improved pinning using the MOCVD reactor located at ORNL.
- Microstructural evaluation of Nb incorporated MOCVD-YBCO films reveals the characteristics of defects that provide improved pinning performance
- Established the UV-assisted MOCVD REBCO film growth capability at ORNL.
- Collaborated with Los Alamos National Laboratory scientists to demonstrate the growth of IBAD-MgO on solution planarized Hastelloy substrates.
- Collaborated with Argonne National Laboratory scientists to characterize Nb-incorporated MOCVD-YBCO films produced at ORNL.

2011 Plans and Expectations:

The CRADA work has provided an improved understanding of the fundamental properties of the IBAD-MgO template including planarization of mechanically polished hastelloy substrates using solution Al_2O_3 layers, functionalized LMO buffers and MOCVD-REBCO in the process. The activity is closely coupled to SuperPower's REBCO scale-up program and has assisted SuperPower in implementing a robust manufacturing process.
FY 2011 Plans include:

1. Continue ORNL assistance to SuperPower/University of Houston for fabricating long-length, robust IBAD-MgO/LMO/MOCVD-REBCO with improved flux pinning properties in pilot-scale production level.
2. Continue development of dip-coating conditions to growth nanocrystalline buffers and demonstrate the growth of robust buffers and superconductor films.
3. Continue optimization of pinning mechanisms and microstructure-processing-property correlations in thick REBCO films produced in manufacturing.
4. Investigate the efficacy of UV-assisted MOCVD process to increase precursor conversion efficiency and improved reaction kinetics.
5. Transfer the knowledge learned from the MOCVD system regarding growth of REBCO films located at ORNL to SuperPower.

Technology Transfer, Collaboration, Partnerships:

Close collaboration and interaction between ORNL, University of Houston, and SuperPower has resulted in significant advancement in process understanding and subsequently in the development of a robust manufacturing process at SuperPower. The collaboration functions through regular conference calls, frequent sample exchanges, joint development and joint materials evaluation and testing, and CRADA meetings. Joint publications have resulted from this work. Furthermore, this team has also collaborated with both Argonne National Laboratory and Los Alamos National Laboratory scientists to evaluate substrates and characterize films produced at ORNL.