

## Superconductivity for Electric Systems 2006 Project Summary

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<b>PROJECT TITLE:</b>	<b>Non-Vacuum Deposition of Buffer Layers and IGC CRADA</b>
<b>ORGANIZATION:</b>	<b>National Renewable Energy Laboratory</b>
<b>PRESENTERS:</b>	Raghu Bhattacharya
<b>FY 2006 FUNDING:</b>	<b>\$220K (NREL Buffer Layers) + 100K (CRADA work with IGC Superpower)</b>

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**Project Purpose and FY 2006 Objectives:** The U.S. Department of Energy's vision is, "Low-cost, high-performance YBCO-coated conductors will be available in kilometer lengths." One of the important critical needs to achieve this goal is to develop a simple low-cost technology for producing buffer layers for low-cost metal substrates. Our project features non-vacuum electrodeposition processing technologies, which are potentially low-cost, continuous processes that produce long lengths of tapes. YBCO is the primary HTS material system under investigation. The realization of biaxially textured "thick" oxide superconductor films with high transport current is the primary objective for the program. We have the following specific objectives for FY 2006.

1. Prepare electrodeposited biaxially textured CeO<sub>2</sub> buffer layer for YBCO HTS.
2. Prepare electrodeposited biaxially textured Sm-doped CeO<sub>2</sub> buffer layer for YBCO HTS.
3. Prepare electrodeposited biaxially textured La<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub> buffer layer for YBCO HTS.
4. Prepare electrodeposited biaxially textured Gd<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub> buffer layer for YBCO HTS.
5. Prepare electrodeposited biaxially textured Sm<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub> buffer layer for YBCO HTS.
6. Prepare electrodeposited biaxially textured multiple buffer layers for YBCO HTS.
7. Establish CRADA with SuperPower on electrodeposition.

### **FY 2006 Performance and FY 2007 Plans:**

#### **Summary of FY 2006 performance:**

1. Details about the understanding of formation of crack-free biaxially textured electrodeposited CeO<sub>2</sub> and Sm doped CeO<sub>2</sub> have been evaluated.
2. Electrodeposited biaxially textured La<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub> buffer layers for YBCO HTS were prepared.
3. Electrodeposited biaxially textured Gd<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub> buffer layers for YBCO HTS were prepared.
4. Electrodeposited biaxially textured Sm<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub> buffer layers for YBCO HTS were prepared.
5. Electrodeposited biaxially textured multiple buffer layers for YBCO HTS were prepared.
6. Good-quality biaxially textured YBCO has been prepared on electrodeposited buffer layers.
7. A new pulse-current measurement system at NREL was built to measure the high current carrying superconductor tapes (specially designed for IGC SuperPower CRADA work).
8. CRADA with SuperPower on electrodeposition work was finalized. NREL and IGC SuperPower have been experimenting with direct copper electroplating on YBCO tapes. The initial results are very promising wherein the YBCO properties have not been degraded even though the YBCO tapes were directly exposed to the electrodeposition solution. Since SuperPower uses an electroplating process for their surround copper stabilizer, this process could be well integrated with their manufacturing scheme.

#### **Proposed FY 2007 plans:**

1. Evaluate NREL's electrodeposited biaxially textured buffer layers to obtain YBCO superconductor with current density  $>10^6$  A/cm<sup>2</sup>. Collaborative effort with other national laboratories and industries.
2. Select all electrodeposited multiple buffer layer to layers to obtain MOD YBCO superconductor with current density  $>10^6$  A/cm<sup>2</sup> (collaborative work with UES, Inc.).

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3. Perform the CRADA work with IGC SuperPower. Emphasis will be given to resolve the issue with the electrical resistance between the YBCO film and electrodeposited copper.
4. Technical communications (DOE review meetings, FWP, CRADA, research collaborations, publications).

### **FY 2006 Results:**

1. Electrodeposited biaxially textured multiple buffer layers for YBCO HTS were prepared.
2. Electrodeposited biaxially textured CeO<sub>2</sub>, Sm-doped CeO<sub>2</sub>, La<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub>, Gd<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub>, and Sm<sub>2</sub>Zr<sub>2</sub>O<sub>7</sub> buffer layers for YBCO HTS were prepared.
3. CRADA with SuperPower on electrodeposition work was finalized. The initial results are very promising wherein the YBCO properties have not been degraded even though the YBCO tapes were directly exposed to the electrodeposition solution. Since SuperPower uses an electroplating process for their surround copper stabilizer, this process could be well integrated with their manufacturing scheme.

### **Publications released since the previous peer review in 2005:**

1. Raghu Bhattacharya, Sovannary Phok, Priscila Spagnol, and Tapas Chaudhuri, "Electrodeposited biaxially textured buffer layer for YBCO superconductor oxide films," *Journal of Electrochemical Society*, 153, (5) C273-C276 (2006).
2. Tapas Chaudhuri, Priscila Spagnol, Sovannary Phok, Raghu Bhattacharya, "Effect of seed layer on biaxial texturing of pulsed laser deposited YSZ films on electrodeposited Ir/Ni-W tapes," *Physica C*, article in press.
3. Sovannary Phok and Raghu Bhattacharya, "Effect of Samarium doping on electrodeposited CeO<sub>2</sub> thin film," *Physica Status Solidi*, submitted.
4. Tapas Chaudhuri, Sovannary Phok, and Raghu Bhattacharya, "Pulsed-laser deposition of cerium oxide thin films on glass substrates at room temperature," *Thin Solid Films*, submitted.

**Research Integration:** NREL and SuperPower Corporation are working together on a new CRADA toward the development of low-cost YBCO-coated conductors. NREL is also working with other national laboratories and UES, Inc., on YBCO-coated conductors.