

**2010 Advanced Cables and Conductors Peer Review
Project Summary**

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| Project Title: | Strategic Substrate Development for Coated Conductors |
| Organization: | Oak Ridge National Laboratory |
| Presenters: | Amit Goyal and M. Parans Paranthaman (ORNL) |
| FY 2010 Funding: | \$450 K (DOE to ORNL) |

Overall Project Purpose and Objectives:

The objective of this project is to conduct fundamental research in the broad areas of substrate or template and buffer layer development. The results of this project provide new insights in these areas and suggest methods to improve substrate and buffer fabrication at partner companies such as American Superconductor and SuperPower. The overall purpose of this project is to enable potentially low-cost, high throughput, high yield, manufacturing processes for substrate and buffer fabrication, and to gain fundamental understanding of the growth of buffer layers for both RABiTS and IBAD-MgO templates. This understanding is critical to the development of a reliable, robust, long-length manufacturing process of 2G wires.

FY 2010 Plans were:

1. Demonstrate thicker epitaxial YBCO films on R-plane faceted sapphire fibers fabricated using the SSIFFS process
2. Demonstrate multiple fiber growth of R-plane faceted SSIFFS
3. Further develop alloy substrates for the RABiTS process (alternative alloys and/or composite substrates)
4. Develop simplified buffer architectures leading to improved RABiTS/IBAD-MgO template performance and/or reduced manufacturing cost
5. Develop process conditions to increase thickness per coat and/or reduce number of coats for solution Al₂O₃ layers for the IBAD process
6. Transfer the knowledge learned from the substrate and buffer development research to our industry partners

2010 Approach and Results:

We have conducted experiments on YBCO film deposition on faceted fibers made using the SSIFFS process. We have continued to investigate methods to achieve biaxial texture in substrates which are mechanically strong and have reduced magnetism. In the area of buffer layer development, the emphasis areas included – development of buffers which improve the texture compared to the substrate, development of multifunctional buffer layers, reduction in the number of buffer layers and development of more robust buffers.

Specific results and accomplishments in FY2010 include:

- Processing conditions were developed to grow thicker REBCO films on R-plane sapphire substrates and on sapphire fibers with R-plane facets made using the SSIFFS process
- Experiments were conducted to demonstrate growth of multiple SSIFFS from the melt simultaneously
- Explored texture formation in higher W containing Ni-W alloys
- Developed new buffers reported for the first time which result in improved texture and offer the possibility of serving as a multifunctional buffer in the RABiTS stack

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- Developed process conditions to increase the thickness per coat and reduced number of coats for solution Al₂O₃ layers for planarizing Hastelloy substrates used in the IBAD process

2011 Plans and Expectations:

U.S. HTS wire manufacturers are now in a position to produce reasonable quality coated conductors in “pilot-scale” mode. Presently, up to 3-5 buffer layers are used in the standard RABiTS/IBAD-MgO architecture of 2G wires. To reduce cost and complexity, as well as associated mechanical and reliability concerns, it is highly desirable to reduce the number of buffer layers. This can be accomplished by utilizing multi-functional materials that can combine the tasks of two buffers into one. Development of robust buffer stacks on these buffers is also needed.

FY 2011 Plans include:

1. Continue to further develop substrate technology for the RABiTS process – in particular the very high, W-containing, NiW alloys
2. Continue development of simplified buffer architectures leading to improved RABiTS/IBAD-MgO template performance and/or reduced manufacturing cost
3. Further develop the new and promising SSIFFS process to fabricate long –lengths of low-aspect ratio or “round” templates for epitaxial growth of HTS conductors
4. Transfer the knowledge learned from the substrate and buffer development research to our industry partners

Technology Transfer, Collaboration, Partnerships:

Close collaboration and interaction with American Superconductor Corporation (AMSC) and SuperPower has resulted in significant advancement in process understanding and subsequently in the development of a robust manufacturing process at AMSC and SuperPower. Several publications and presentations have resulted from this work. Close collaboration with LANL on the evaluation of solution based nanocrystalline Al₂O₃ layers resulted in robust IBAD templates with possibly reduced manufacturing cost. We worked closely with sapphire companies capable of edge-defined film fed growth was performed. Several publications and presentations have resulted from this work. The SSIFFS process developed in this project received an R&D100 award in 2009.