

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

Project Title:	Wire Development Group: Understanding and Engineering the Performance of 2G HTS Wire
Organizations:	Los Alamos National Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, Florida State University, Industrial Research Limited, and American Superconductor Corporation
Presenters:	Martin Rupich (AMSC), Dmytro Abraimov (FSU), Terry Holesinger (LANL)
FY 2010 Funding:	LANL - \$700 K; ANL - \$400 K; ORNL – \$450 K; FSU - \$150 K; AMSC - \$1,700 K

Overall Project Purpose and Objectives:

The Wire Development Group (WDG) is a long running, dynamic, multi-institutional collaboration focused on advancing the materials science of second generation (2G) high temperature superconductor wire for energy and magnet applications in the U.S. and international markets. The WDG combines the expertise and resources of three DOE national laboratories (ANL, LANL and ORNL), a leading university program in applied superconductivity (FSU) and an international research laboratory (IRL) with the world's leading 2G HTS wire manufacturer (AMSC). The WDG focus on advancing the material science of epitaxial growth processes and understanding structure-property-processing relationships has been instrumental in establishing the solution based Metal Organic Deposition YBCO(MOD) / RABiTS™ process as the premier approach for the production of high performance, long length 2G wires.

This team of scientists brings a unique mix of characterization and processing expertise required to develop a fundamental understanding of key material science issues and utilize this knowledge in developing unique solutions that are readily implemented into AMSC's 2G manufacturing process.

During the past year, the WDG has focused on four critical issues needed for a successful commercial 2G wire technology: (1) understanding the key processing parameters controlling the growth of thick, high I_c YBCO films; (2) characterizing key microstructural features that enhance vortex pinning and developing processing routes to engineer specific pinning properties into the YBCO films; (3) characterizing grain-boundary and bulk-pinning limited regimes; and (4) development of advanced techniques for characterizing and correlating structure-property-processing relationships critical to the performance of 2G wire.

2010 Approach and Results:

The focus of the WDG actives in FY2010 was advancing the fundamental material science knowledge of the epitaxial growth of thick films by solution-based growth processes, developing a scientific understanding of the process(chemistry)-microstructure-property relationship of flux pinning microstructures in ex-situ grown YBCO films and the development of advanced characterization techniques required for elucidating key microstructure-process-property relationships critical to the manufacture of the solution-based YBCO/RABiTS wires. The WDG research focused specifically on areas identified as critical for both near-term and long-term advancement of the 2G wire technology. Specific near-term performance metrics that the WDG program supported were (1) extending the single-layer thickness of solution-based YBCO films, (2) demonstrating increased pinning forces in thick YBCO films and (3) enhancing the critical current at 30K in fields of 1-3T.

2011 Plans and Expectations:

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The WDG activities, during FY2011, will focus on advancing the material science understanding of key aspects of the YBCO(MOD) / RABiTS™ process that have been identified as critical for advancing the performance of 2G wire. These efforts will be critical to defining the path for the next significant advance in the performance of the YBCO(MOD) / RABiTS™ technology. Specific activities will include:

- Identifying factors limiting the intrinsic thickness of the single-coat YBCO decomposition-reaction process
- Characterizing and defining process-microstructure-property relationships of YBCO(MOD) microstructures and in-field critical current
- Development of advanced characterization techniques for identifying CLM's and insuring quality in 2G wires
- Advancing the material science understanding of the role of the buffer layer surface chemistry on the epitaxial nucleation and growth of YBCO.

Technology Transfer, Collaboration, Partnerships:

The WDG is, by its very nature, a close integration of multiple institutions working effectively together to develop the materials science underlying HTS wire and enabling world leadership in HTS wire production by a U.S. company. The WDG also accesses the expertise of other scientists from the national laboratories and universities around the world to develop a better understanding of novel pinning mechanisms and thick film growth. Periodic meetings, video conferences, individual visits, emails, phone calls, and inter-organizational sample exchanges insure rapid coordinated progress by exploiting the unique skills at the different laboratories. A balance of proprietary technology and publishable results is maintained. An atmosphere of trust supports a positive and enthusiastic *esprit de corps*. The range of expertise and cooperation in the group allows a comprehensive approach to issues in 2G wire development.

The fundamental knowledge generated by the WDG is rapidly assimilated by the scientists and engineers at AMSC and converted into practical processes that are introduced into the 2G manufacturing process to either enhance performance or overcome processing or materials limitations. Key technologies integrated into AMSC's manufacturing process over the past year include (1) the introduction of new equipment and processes for single-coat, thick YBCO films and (2) optimization of processing parameters for controlling the pinning microstructure in long length production wires. The broad dissemination of WDG studies in national meetings, international conferences and peer reviewed journals insures that the most fundamental aspects of the 2G research are available to the wider technical community.