

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

Project Title:	R&D of High Performance 2G HTS Wire for Commercial Readiness
Organization:	American Superconductor
Presenters:	Martin Rupich, Cees Thieme and Jack McCall
FY 2010 Funding:	\$750 K

Overall Project Purpose and Objectives:

The purpose of this R&D program is to accelerate development in key technical areas identified, by AMSC and DOE, as critical for transforming 2G HTS wire into a broad-based commercial technology. This program is designed to increase performance of 2G wire, boost the annual 2G wire manufacturing capacity in terms of kA-m/year and reduce materials costs. The project is structured around the following four critical technical areas and is focused on the development of process innovations that can be integrated into AMSC 2G wire manufacturing process.

- Low ac loss RABiTS substrates
- High I_c in solution-based YBCO films
- Enhanced pinning in solution-based YBCO films.
- Materials cost reduction

The accelerated research and development enabled by this Program will insure that the performance of 2G wire continues to improve to the level required for achieving broad-based acceptance in commercial and military applications.

2010 Approach and Results:

AMSC has successfully established a 2G HTS manufacturing process based, on a wide-web YBCO(MOD) / RABiTSTM technology, with previous support from the DOE-DOD Title III and DOE Wire Initiative programs. The current manufacturing process produces 344 superconductors wire in lengths to 500 meters with critical currents in the 80 – 120 A (200 – 300 A/cm-w) range for commercial sales.

The DOE Wire Readiness program, which began in April 2010, is an integrated effort encompassing research, development and demonstration of innovative 2G wire manufacturing processes that are suited for mass manufacturing. The fundamental research and development is initially carried out with R&D samples and then transferred to reel-to-reel processing equipment. As process innovations are developed, they will be evaluated in sufficient lengths to be representative of manufacturing and, when appropriate, incorporated into AMSC's manufacturing line.

The primary effort during the past year has focused on developing a single-coat process for thicker YBCO films, enhancing pinning at temperatures relevant to wind generator applications and developing composite substrates with reduced ferromagnetic loss. \

2011 Plans and Expectations:

The R&D project activities during FY2011 will focus on developing innovative solutions to the four technical areas identified as critical for transforming 2G HTS wire into a broad-based commercial technology. This effort will identify key technical innovations enabling improvements in wire performance that will be "ready" for insertion into the manufacturing process. Specific activities will include:

- Higher I_c – Continued development of innovative thick film processing of YBCO films and demonstration in 344 superconductors.

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- Low-loss RABiTS Substrate – Continued development of a composite RABiTS substrate with reduced ferromagnetic loss in a 344 superconductors wire
- Enhanced Pinning – Characterizing and defining process-microstructure-property relationships of YBCO(MOD) microstructures and in-field critical current and evaluating novel pinning microstructures compatible with solution-based YBCO films.
- Materials Cost Reduction – Innovative deposition processes and alternate materials will be developed to reduce the silver content of the current metallic stabilizer layer in the 344 superconductor architecture.

Technology Transfer, Collaboration, Partnerships:

AMSC maintains active collaborations with leading scientists in the DOE national laboratories and universities through the Wire Development Group (WDG) and individual CRADA's. The WDG, comprised of AMSC, ORNL, LANL, ANL, Applied Superconductivity Center at FSU and Industrial Research Limited (IRL), is focused on developing the material science behind nucleation and growth in RABiTS/MOD HTS films, characterizing vortex pinning, developing novel approaches to enhance pinning in *ex-situ* YBCO films and the identifying and characterizing dissipation mechanisms in 2G wire.

The AMSC-ORNL collaboration is focused on the development and characterization of low ferromagnetic loss RABiTS substrates, the development of novel pinning in *ex-situ* YBCO films and development lower cost film deposition processes.

The AMSC-LANL CRADA also supports the characterization of low ferromagnetic loss substrate and ac loss in 2G wires and the development of advanced characterizations tools for 2G wire.

The ANL, LANL and ORNL CRADA's also provide access to the expertise and critical characterization techniques required for advancing the field of epitaxial film growth and helping transform this advanced technology into a robust, commercial manufacturing process.