Organization:	**Oak Ridge National Laboratory/American Superconductor Corporation**
Project Title:	**AMSC CRADA: Development of Reel-to-Reel Processing of YBCO Coated Conductors**
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FY 2002 Funding:	**$0.9 million (ORNL) (Includes funding from DOE EE-RE, DOE SC-LTR, and funds-in from AMSC)**

Project Purpose and FY 2002 Objectives: To develop a basic understanding of fundamental issues, and provide guidance for the practical solution of problems related to reel-to-reel processing of coated conductor for high-temperature and high-field applications. The primary objectives for FY 2002 are:

1. Development of materials and processes for preparing continuous lengths of oxide-buffered, deformation textured, alloy substrates.
2. Demonstration of significant texture uniformity in the metal/alloy substrate and in the epitaxial oxide layers including the superconductor layer.
3. Demonstration of uniform critical current over >1-m length of conductor with a Ni-based alloy substrate by reel-to-reel processing at all steps.
4. Detailed characterizations of RABiTS and YBCO coated conductors in both short and long lengths.

FY 2002 Performance and FY 2003 Plans: In FY 2002, all milestones were achieved as planned. Long lengths of textured metal and alloys were fabricated at American Superconductor Corporation (AMSC) based on processes first demonstrated at ORNL. A sharp texture with a ~100% cube texture with high homogeneity was achieved. A significant portion of the effort was focused on understanding, optimizing, and refining the metal surface structures necessary for growth of high quality, epitaxial, oxide seed layers on the textured metals/alloys using reel-to-reel processing, based on transfer of the ORNL knowledge base on surface superstructures. The basic materials science and technology related to reel-to-reel processing of barrier and cap layers developed at ORNL were also successfully transferred to AMSC. Superconductor was successfully applied to fully-buffered substrates using AMSC's proprietary solution-based, TFA-YBCO process.

A close collaboration between AMSC and ORNL has produced significant progress in all steps of reel-to-reel fabrication of fully-buffered RABiTS, resulting in a reproducible process . Epitaxial YBCO on meter long tapes was found to show excellent properties and uniformity. The team has jointly developed a potentially low-cost manufacturing process for a commercial conductor.

FY 2003 plans include:

1. Jointly developed improved alloy substrates in long lengths which could have any or all of the following characteristics–sharper texture, higher strength, lower magnetism, and/or surfaces on which it is easier to deposit epitaxial oxide layers.
2. Develop methods to completely characterize the relationships between "texture" and "grain boundaries," and develop a metric to use in the development of alloy substrates with respect to texture on AMSC's substrates.

3. Develop simpler, faster, lower-cost, alternate buffer layer architectures that are compatible with the TFA-YBCO process.
4. Develop methods to fully characterize the properties of barrier layers using microstructural techniques such as TEM, SIMS, EBSP, SEM, Auger Spectroscopy, etc., and suggest corresponding metrics for each method.
5. Work with AMSC to help enable demonstration at AMSC of a high performance, 10-m, continuously processed YBCO tape on RABiTS, fabricated via reel-to-reel processing at all steps.

FY 2002 Results:

Long lengths of well-textured Ni and Ni-W alloys were fabricated by reel-to-reel rolling processes. Substrates typically have excellent texture homogeneity and in-plane texture of ~ 7º full-width-half-maximum (FWHM). The substrates are also relatively free of defects such as scratches, etc. The substrates are annealed in a reel-to-reel process. Reel-to-reel equipment was designed to enable pretreatment of the metal surface prior to oxide deposition. Reel-to-reel equipment was designed to deposit epitaxial oxide layers on the metal/alloy tapes. AMSC deposited YBCO films over meter lengths using a proprietary TFA-YBCO process. Excellent electrical performance of these one-meter lengths of wires was achieved. In addition, ORNL and AMSC have jointly characterized the tapes in detail and studied the substrate, buffer, and superconductor characteristics towards fundamental understanding of coated conductor development.

Technology Integration: A very close collaboration and interaction between ORNL and AMSC has resulted in significant technology transfer from ORNL to AMSC. Regular bi-weekly conference calls, frequent sample exchanges, joint development and joint materials evaluation and testing have resulted in significant and rapid progress over the course of the last year. An even closer interaction is envisioned for future work.