

Superconductivity for Electric Systems 2006

Project Summary

YOUR ORGANIZATION:	Sandia National Laboratories
PROJECT TITLE:	All-Solution Deposited Coated Conductors
PRESENTERS:	Paul Clem
FY 2005 FUNDING:	\$400K
FY 2006 FUNDING:	\$400K

Overall Project Purpose and FY 2006 Objectives: The purpose of this project is development of economical, scaleable, all-solution deposition techniques for continuous processing of 2nd generation coated conductor tapes. Particular focus has been placed on all-solution processing of buffer layers and YBCO, and in increasing processing speed (deposition rate, organic burnout, and YBCO crystallization). Sandia has a long history in sol-gel chemistry, scale-up of solution-deposited materials, and BaF₂- and trifluoroacetic acid-based (TFA) YBCO processing, and is applying this background to integration of high quality buffer layer and YBCO conductor process methods on commercial substrates. The solution deposition processes developed are inherently capable of continuous, 90-360 m/h deposition rates, and have promise to be the lowest cost method of producing 2nd generation coated conductors, if vacuum crystallographic quality can be attained. Towards this goal, we have substantially achieved our FY2006 project milestones in collaboration with LANL and AMSC:

- 1) Continue multilayer, multimicron YBCO development on SrTiO₃/NiW
goal: 200A/cm, RTA + vacuum conversion TFA-MOD process YBCO films
- 2) Reel to reel dip coating deposition efforts (at SNL, ORNL, LANL):
meter-length buffer deposition
meter-length YBCO multilayering
multimeter Y₂O₃ planarization of LANL substrates for IBAD
- 3) 10-100cm striated YBCO contact printing
- 4) Continue AMSC CRADA on solution buffers, TFA YBCO
goal: > MA/cm² YBCO on MOD CeO₂/SrTiO₃/NiW or SrTiO₃/NiW
- 5) Investigate Y₂O₃ process transfer to LANL Research Park

FY 2006 Results and Accomplishments:

Summary of FY 2006 performance:

- 1) Collaborated with commercial and inter-laboratory partners to enable development and scale-up of solution-derived 2nd generation coated conductors: (i) a CRADA with American Superconductor Corporation (AMSC) for evaluation of Sandia solution buffers, and application of Sandia methods for optimization of AMSC buffer and YBCO processes, (ii) collaboration with Los Alamos National Laboratory (LANL) on IBAD MgO substrates, planarization of substrates for IBAD, and TEM of SNL YBCO/SrTiO₃/NiW and joint YBCO/STO/IBAD MgO/hastelloy. We have continued research on solution-deposited SrTiO₃ single buffer layer structures on NiW, followed by solution-deposited 0.25-1µm YBCO.
- 2) Used the SNL TFA/DEA YBCO process to produce 0.8 µm, 1.7 MA/cm² films (139 A/cm I_c), on CeO₂/SrTiO₃/Ni-W, 2.0 MA/cm² films on SrTiO₃/NiW. Investigated multicrystallization and multicoating processing for building up thicker (1-2 µm) YBCO.
- 3) Completed a three year CRADA with AMSC on joint solution-deposited coated conductor research. Demonstrated high quality YBCO atop SrTiO₃/NiW buffer stacks.
- 4) Demonstrated J_c = 1.5 MA/cm² YBCO/epi-MgO/IBAD-MgO on solution-planarized Hastelloy substrates
- 5) Demonstrated J_c > 1.7 MA/cm² YBCO on SrTiO₃/NiW RABiTS substrates
- 6) Developed new approach for fast YBCO multilayering to achieve thick (1-2 micron) MOD YBCO

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FY 2007 Plans and Expectations: Identify and describe your FY 2007 plans and expected FY 2007 milestones. Explain any key technical barriers that you foresee and your strategy to overcome these barriers. If applicable, please provide 2008, 2009, and 2010 milestones.

- 1) Continue solution buffer technology evaluation and technology spin-off
 - develop single deposition step buffer on NiW RABiTS
 - demonstrate long length YBCO & SrTiO₃ on IBAD MgO for solution-deposited IBAD coated conductors
- 2) Demonstrate high throughput reel-to-reel IBAD substrate planarization
- 3) Develop & optimize 2 μm thickness TFA YBCO by multilayer rapid processing for 300A/cm coated conductors
- 4) Continue low AC loss structure novel fabrication methods (e.g. direct contact printing)

Research Integration: Collaborated with commercial and inter-laboratory partners to enable development and scale-up of solution-derived 2nd generation coated conductors:

- (i) CRADA with American Superconductor Corporation (AMSC) for evaluation of Sandia solution buffers, and application of Sandia methods for optimization of AMSC processes, including focused ion beam sample sectioning, scanning electron microscopy, and buffer layer chemical characterization.
- (ii) Collaboration with Los Alamos National Laboratory (LANL) on
 - a. solution YBCO growth on IBAD MgO substrates
 - b. tech transfer of reel-to-reel solution substrate planarization for IBAD MgO deposition
 - c. TEM of SNL YBCO/SrTiO₃/NiW and joint YBCO/STO/IBAD MgO/hastelloy.
 - d. Investigation of novel low AC loss topology fabrication methods