PROJECT TITLE:	**AC LOSS AND STABILITY MEASUREMENTS ON HTS MATERIALS AND CRYO-DIELECTRIC STUDIES**
ORGANIZATION:	**FLORIDA STATE UNIVERSITY CENTER FOR ADVANCED POWER SYSTEMS**
PRESENTERS:	Sastry Pamidi and Horatio Rodrigo
FY 2006 FUNDING:	~ $ 1,000,000

Project Purpose and FY 2006 Objectives: Provide a brief project description. Identify specific project goals and objectives. Explain how this project contributes to the achievement of the U.S. Department of Energy's Superconductivity Program goals. Describe the expected benefits of your project for the U.S. DOE and the nation.

The goal of AC loss and stability measurements at CAPS is generate the critical data on losses of HTS materials over a wide parameter range. The main emphasis of the work at CAPS is variable temperature measurements. One of the objectives is to design and build a cryocooler based versatile facility to measure total AC losses and stability of 15-20 cm long pieces of HTS materials as functions of temperature, DC and AC transport current, frequency, DC and AC magnetic field, magnetic field orientation.

A second objective is to use the existing facilities to measure ac losses and stability of YBCO material at 77 K. The objective also included developing numerical models for calculating AC loss and stability in YBCO tapes.

The research on AC losses and stability of HTS materials will generate valuable understanding and data useful for the various DOE superconductivity projects. The wire manufactures will also will use the results in improving the conductor properties.

The objective of cryogenic dielectrics research is to set up new laboratory to study the dielectric characteristics of a variety of materials suitable for devices operating at cryogenic temperatures. The temperature range of interest is between 30 K and 77 K. This facility allows for dielectric research of a very high quality which will be beneficial not only for DoE projects but for the dielectric industry at large.

FY 2006 Performance and FY 2007 Plans: Describe how last year's plans were carried out and the merit of future year plans. Describe how goals/milestones were met. Identify and describe your FY 2007 plans and expected FY 2007 milestones.

The design, fabrication, and installation of all the components of the new measurement system were completed. AC loss and stability measurements were conducted on several YBCO samples using the existing facilities. The results of numerical calculations of AC loss measurements matched well with the results of experiments.

The setting up of the dielectrics laboratory is almost complete. All the equipment has been installed.

The plans for FY2007 are to commission the new measurement facility and through systematic experiments establish the ranges for various parameters that can be applied for AC loss and stability measurements using the new setup.

Design several samples holders for magnetization loss, transport loss, and total loss measurements. Design LabView routines for the various measurements and data acquisition.

Conduct a series of systematic experiments to generate AC loss and stability data on a variety of commercial YBCO samples over a broad parameter range.

The FY 2007 plan for the dielectrics laboratory is to commission the equipment and cryostat to start performing the experiments. The objectives of the project are: identify the best possible candidate materials for insulation in motors, transformers and cables at cryogenic temperatures. The materials will have to withstand not only the basic operating voltages and currents, but also to be able to operate reliably under highly stressed conditions such as faults and frequent switching of IGBTs, Thyristos and MOSFETs. In addition the insulation will be designed to withstand the effects of transient currents such as inrush current on starting induction motors and transformers.

FY 2006 Results: Describe specific technical results achieved, milestones reached, publications released, and any

other accomplishments since the previous Peer Review in 2005.

A series of AC loss measurements were carried out on several BSCCO and YBCO samples from a variety sources. Transport loss measurements were carried at several temperatures in the range 45 – 90 K in the frequency range 25 – 400 Hz. Improvisation were made for calorimetric AC loss measurements to adapt them YBCO wide tape. Calorimetric measurements were validated using the data from electromagnetic methods. Transport loss measurements were carried out at different frequencies for both BSCCO and YBCO conductors.

A new probe was designed to study quench propagation in the temperature range of 35 - 77 K. Using the probe, the effect of defects on quench behavior of YBCO tape samples was understood. An over-current pulse was used to initiate the quench. Numerical model was developed to understand quench propagation.

Quench propagation measurements were performed on BSCCO and YBCO samples under DC and AC transport current at 45 K and 65 K.

Publications:

1. D.N. Nguyen, P.V.P.S.S. Sastry, D.C. Knoll, G. Zhang and J. Schwartz, "Experimental and numerical studies of the effect of phase difference between transport current and perpendicular applied magnetic field on total ac loss in Ag-sheathed (Bi, Pb)$_2$Sr$_2$ Ca$_2$Cu$_3$O$_{10}$", J. Appl. Phys., **98** (073902), 1-6 (2005)
2. D.N. Nguyen, P.V.P.S.S. Sastry, G.M. Zhang, D.C. Knoll and J. Schwartz, "Relationship between critical current density and self-field losses of Ag-sheathed (Bi,Pb)$_2$Sr$_2$Ca$_2$Cu$_3$O$_x$ tapes," Advances in Cryogenic Engineering Materials **52**, 696 (2006)
3. D.N. Nguyen, P.V.P.S.S. Sastry and J. Schwartz, "Waveform of loss voltage in Ag-sheathed Bi2223 superconducting tape carrying ac transport currents" Advances in Cryogenic Engineering Materials **52**, 869 (2006)
4. D.N. Nguyen, P.V.P.S.S. Sastry, D.C. Knoll, J. Schwartz, "Electromagnetic and calorimetric measurements for AC losses of an YB$_2$Cu$_3$O$_{7-\delta}$ coated conductor with Ni-alloy substrate" submitted to Supercond. Sci. Technol. (Submitted**)**
5. X. Wang, A.R. Caruso, M. Breschi, G. M. Zhang, U.P. Trociewitz, H.W. Weijers, J. and Schwartz, "Normal zone initiation and propagation in Y-Ba-Cu-O coated conductors with Cu stabilizer," IEEE Trans. Appl. Supercond., 15 (2), 2586-2589 (2005)
6. G.M. Zhang, D. C. Knoll, D. N. Nguyen, P. V. P. S. S. Sastry, U.P. Trociewitz, X. Wang, and J. Schwartz, "Temperature Dependence of Critical Currents and AC Losses in (Bi,Pb)$_2$Sr$_2$Ca$_2$Cu$_3$O$_x$ and YBa$_2$Cu$_3$O$_x$ Tapes," (to be submitted to Supercond. Sci & Technol.)
7. G.M. Zhang, D. C. Knoll, D. N. Nguyen, P. V. P. S. S. Sastry, U.P. Trociewitz, X. Wang, and J. Schwartz, "Quench Behavior of YBa$_2$Cu$_3$O$_7$ Coated Conductors with AC Transport Currents," (to be submitted to IEEE Trans. Appl. Supercond.)

Research Integration: Identify cooperative efforts and technology transfer/outreach activities related to this and related projects. When answering, consider work with private industry, state and local government, federal government, national laboratories, academia, and trade associations.

- Collaborated with Tai-Yang Research Company in characterizing YBCO current leads and applied for funding from Florida Space Research Institute.
- This project supports and contributes to the HTS transformer project funded by ONR
- There are plans afoot to collaborate on joint ventures with Oak Ridge National Laboratory