

FAST CENTER

Dr. Paul O. Biney, Director

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Overview

The Future Aerospace Science & Technology (FAST) Center at Prairie View A&M University (PVAMU) was established with funds from the US Air Force Office of Scientific Research in 1995. The focus of the center is on development, processing and characterization of lightweight and high temperature structural materials and nanomaterials. The center is based in the College of Engineering and managed by a director and two principal investigators. There are three thrust areas in the center: Research, Education, and Technology Transfer. The effort is to enable PVAMU to advance the processing, characterization, and environmental simulation of the state-of-the-art composites and nanocomposites for use in both military and civilian applications.

Objectives:

- Conduct research in the development of new methods in nanomaterial processing, fabrication & characterization with emphasis on developing understanding and controlling of processing factors that would lead to multifunctional nanomaterials tailored for improved (1) structural/mechanical properties, (2) electrical and thermal properties, (3) EMI and radiation shielding, (4) barrier properties, and (5) thin films for sensor and membrane applications
- Foster close research and subcontract relations with aerospace, material processing, oil and gas companies as well as private and government research labs to advance the properties and processing technology of polymeric composites.
- Provide opportunities for training graduate and undergraduate students in materials and processing technology and prepare them to assume leadership role in industry.

FAST CENTER CAPABILITIES

Composite and Multifunctional Nanocomposite Processing

- Development of scalable methods for (1) purification and functionalization (surface modification) of the nanotubes to improve dispersion into polymeric resins during processing, (3) alternative approaches for introducing SWCNTs into nanocomposites during the fabrication process to mitigate processing problems associated with viscosity increase.

- Processing and fabrication of lightweight structural polymer matrix composites and nanocomposites using hand lay-up, vacuum bag molding, autoclave processing, compression molding, RTM and VARTM.

Development of lower cost methods for processing composites

Thermal Characterization of Composites and Neat Resins

- Capabilities for thermal characterization using DSC (with modulation, high pressure, & low temperature capabilities), TGA (with normal and high resolution capabilities), DMA (with cryogenic capabilities)

Rheometric property determination for resins and composites.

Techniques for Optimizing Properties of Field Repaired Composites

- Development of methods for optimizing cure cycles of composites.
- Development of methods to improve shell life of prepregs.
- Development of field repair techniques for composite parts.
- Adhesives research

Environmental Simulation of Operational Envelopes of Composites

- Environmental simulation of service conditions and operational envelopes of composites (within a large range of temperatures, humidity, and pressures) using an advance auto cycling system.
- Hygrothermal and hydrolytic cycling of composites
- Screening of candidate composites for cryogenic tank application.
- Measure effects of highly concentrated oxygen on composite chemistry, and measurement of auto-ignition temperature

Mechanical Characterization of composites and neat resins

- Mechanical testing (Tension, compression, short-beam shear, flexural, and fatigue) for polymers, composites/nanomaterials, and adhesive bonding systems. Fatigue testing
- Testing at cryogenic conditions (down to -196 °C) and at high temperature (up to 600 °C).
- Measurement of permeability of films, neat resins & composites.
- Non-destructive evaluation of composites using C-Scan



THE FAST CENTER TEAM



FAST Center Facilities

Composite Processing Laboratory

Equipment/Instrumentation:

- Autoclave (36" inside diameter 60" long, with operating temperature of 800°F and pressure up to 300 psi, 4 vacuum lines, 12 J type thermocouples, and controlled by ASC CPC controller),
- Heated Platen Press (Working area: 18"x18", max operating temperature: 800°F, load capacity of 50 tons, controlled by CPC software),
- Vacuum Bagging for HT VARTM Processing (the heating rate can be controlled by computer programs),
- RTM: Pressure controlled 2100 cc Radius Engineering RTM injector and tooling
- Dielectrometer for real time cure monitoring and control.

Thermal Analysis and Composite Characterization Laboratory

Equipment/Instrumentation:

- Two TGAs with high Resolution and auto-sampling
- DMA
- Modulated DSC

Optical and Electronic Laboratory

- Nano-scale observation of materials.
- Optical Microscopy,
- SEM, and AFM.

Chemical Analysis Laboratory

Equipment/Instrumentation:

- HPLC (equipped with Waters 15 HPLC pump and 996 photodiode array detector),
- FTIR (Nicolet Magna-IR 560, capable of interfacing with TGA).
Varian 400MHz FT-NMR , UV-VIS

FAST Center Personnel

Dr. P. O. Biney, Director

Nanocomposite processing & characterization
Environmental simulation and field repair, processing and optimization

Dr. Jianren Zhou

Materials characterization, nanomaterials processing & fabrication, mechanical testing

Dr. Remi Oki

Functionalization and chemical characterization.

Mechanical Testing Laboratory

Equipment/Instrumentation:

- Instron testing machine Model 5582.
- Hydraulic Instron testing machine.
Accessories for low and high temperature testing

Environmental Simulation Laboratory

Equipment/Instrumentation:

- Humidity Chambers,
- Automatic Temperature cycling system (-320 °F to 600 °F)
- High Temperature Furnaces,
- Convection Ovens,
- Vacuum Ovens, and Pipe and Parr Bombs

Non-destructive Evaluation laboratory

Equipment/Instrumentation:

C-scan (3-axis laboratory ultrasonic inspection system with a scan inspection Envelop of 24x24x18").

The Composite Permeability Testing System

The system enables researchers to have vital understanding of the permeability of composites and other materials under several environmental conditions. With this system, one can determine the permeability of composites at cryogenic and high temperatures after undergoing various environmental aging. Permeability tests can be conducted under no load or static loading (Tension) at LN2 temperature, and from RT to 250°C. The system consists of a high sensitivity Varian mass spectrometer optimized to sense helium. The composite test specimen is placed between two stainless steel flanges/sealants. The Varian helium mass spectrometer is capable of detecting helium leaks as small as 2×10^{-11} std. cc/s.

Opportunities for Graduate and Undergraduate Research Assistantship

- Strong education and training programs in Materials and Processing areas;
- State-of-the-art analysis and testing equipment;
- Advanced materials research projects related to aviation, space, oil and gas industries and government labs;
- Students trained to assume leadership role in industry;
- New university housing, new library, and a beautiful campus