Composites Manufacturing Technology Center

Recent Research in the Composites Laboratory

Recent Faculty Partners

Charles Bakis
Engrg Sci & Mech
Thomas Boothby
Arch Engrg
Renata Engel
Engrg Sci & Mech
Heath Hofmann
Elect Engrg
George Lesieutre
Aersp Engrg
Cliff Lissenden
Engrg Sci & Mech
Maria Lopez
Civil Engrg
Carlo Pantano
Mat Sci & Engrg
Chris Rahn
Mech Engrg
Joseph Rose
Engrg Sci & Mech
Edward Smith
Aersp Engrg
Kon-Well Wang
Mech Engrg

Contact:
Prof. Charles Bakis
212 Earth & Engineering Sciences Bldg.
The Pennsylvania State University
University Park, PA 16802
ph: 814-865-3178
fax: 814-863-6031
www.esm.psu.edu/labs/cmtc/

The Laboratory

- Organized in 1988
- Focused on interdisciplinary basic and applied research on composite materials and structures: experimental and theoretical

Experimental Facilities

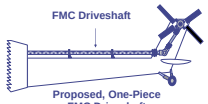
- Filament winder
- Autoclave
- Resin transfer molder
- Pultruder
- Smart presses
- Ovens
- Fume hoods
- Freezer storage
- Clean layup area
- Machine shop
- Fatigue test frames
- Creep test frames
- Envir. chambers (wet/hot/cryo)
- Flywheel spin chamber
- Driveshaft spin stand
- Vibration test stands

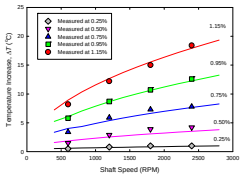
Flexible Matrix Composite Driveshaft

Objectives:
- devise flexible matrix composite (FMC) helicopter driveshaft to transmit high power despite misalignment

Approach:
- select trial elastomeric resin
- evaluate dynamic stiffness and damping behavior of unidirectionally reinforced elastomer (lamina)
- build and test laminated shaft

Progress:
- demonstrated ability to filament wind laminated shaft with elastomeric matrix and 50% by vol. fiber content
- characterized lamina behavior using fractional derivative constitutive law
- predicted stiffness, damping, and self-heating behavior of shaft using thick wall tube analysis





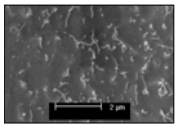
Carbon Nanotube Epoxy Composites

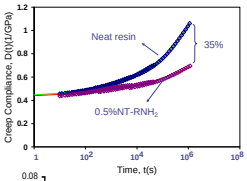
Objectives:
- produce carbon nanotube reinforced epoxy for use in continuous fiber composites
- enhance high temp performance of resin
- enhance damping behavior of resin

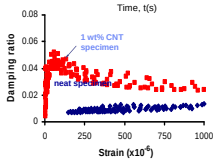
Experimental Approach:
- surfactants
- functionalizing agents
- characterize Tg, CTE, creep resistance

Analytical Approach:
- interfacial stick-slip behavior
- consider ropes, tubes

Progress:
- good dispersion of ropes
- improvement of creep, Tg
- increased damping
- first demonstrated use of NTs in conjunction with filament winding of conventional fibers (2002)





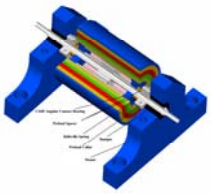


Ultra-High Speed Composite Flywheels

Objective:
- design and build flywheel energy storage systems for satellites and land-based applications

Approach:
- maximize energy storage per unit mass with filament wound carbon/epoxy composites
- minimize electrical losses by careful machine design with low loss materials
- ensure safety by careful material characterization

Representative Flywheels:
- 400-mm-dia. 120 kg flywheel rotor built for land-based application
- 400-mm-dia. 5 kg rotor built to evaluate high temp. superconducting bearings
- 48-mm-dia. flywheel, including high efficiency motor/generator, built for space application
- tip speed of 1100 m/s (over 3x speed of sound) demonstrated

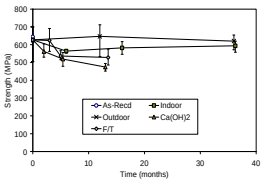


Composite Reinforcement Bars

Objective:
- characterize durability of fiber reinforced polymers used as concrete reinforcement
- create new forms of FRP reinforcements (2D, 3D grids)

Approach:
- real-time and accelerated environmental testing: outdoors, indoors, freeze/thaw, 60°C saturated Ca(OH)2 solution.
- up to 3 years exposure under sustained loads
- evaluate and model strength and bond behavior over time

Progress:
- tensile strength of E-glass/vinylester bars may decrease over time (see figure to right)
- modulus of elasticity of bar and bar/concrete bond unaffected by environment & time
- growth of flexural crack widths accelerated in warmer environments



Core Competencies:
- Mechanics
- Manufacturing
- Testing