Materials Processing and Application Center (MPAD) - Composites at UAB

Applications Development and Prototyping with Composites
Composites R&D at UAB MPAD
6000 sq.ft. (3 faculty, 1 research associate, 1 technician, 12 grad students, 10 undergrads); 20 NDAs with industries

- Application Development emphasis + Basic R&D
- Cost-effective, high performance materials and manufacturing
- Lightweight Automotive/Mass Transit
- Defense – Personnel & Vehicle Protection; Weapon systems
- Marine – Ship structures/Blast & ballistic protection
UAB MPAD Composites Core Competencies

- 10-year history of Concept-to-Prototype-to-Commercialization for military, transportation, aviation, medical devices, energy and other sectors
- Applications development focus in all projects
- Semi-industrial scale labs and experience working with industry (awareness of IP, NDAs and industry specific project sensitivities)
- Technologies for metal replacement with lighter, stronger, cheaper composite alternative
- High-end engineered thermoplastic composites design, development, prototyping & manufacture
- Thermoplastic Extrusion-compression, Pultrusion, Compression molding, Thermoforming, VARTM
- Small, medium and high volume production flexibility
- Commercialization outlet – R&D to commercial transition
Materials Processing and Applications Development (MPAD)
6000 sq. ft of composites R&D space
Research and Development Capabilities of Composites MPAD

**Thermoset / Thermoplastic Polymers & Polymer Matrix Composites, Expertise in Thermoset Liquid Molding**

*(VARTM, RTM)*

**Polymer Characterization, Thermal and Rheological Analysis, DSC, TGA, FTIR etc.**

*Expertise in Thermoplastic Processes (LFT, Thermoforming, Pultrusion, Impregnation)*

Concept Design to Prototype - Full Scale Product / Application Development Cycle, Design & Solid Modeling *(Pro/Engineer, Solidworks)*

*Finite Element Analysis (FEA) and Modeling of Composites (Hypermesh, ANSYS)*

Dynamic Response Modeling such as **Ballistic, Crash, Blast & Low Velocity Impacts (LS-DYNA)**

Process Modeling and **Simulation** for Plastics and Composite Processes

**Static Testing and Material Characterization (All ASTM Static tests - Tensile, Flexure, Compression)**

*Porosity, Absorption, Environmental Behavior and Microstructure Quantification*

**Dynamic Testing (Low Velocity Impact, Charpy / Izod), High Velocity Impact Testing**

**Burn-Through Fire Testing, Electromagnetic Interference (EMI) Shielding Testing, Abrasion Testing**

Nondestructive Testing and Characterization *(Ultrasonic, Vibration, Acoustic Impact NDE etc.)*
Alabama has a rapidly growing automotive industry. Since 1993 the automotive sector has created more than 35,000 new jobs and $6.4 billion in capital investment in Alabama.

The UAB GATE center is focused on training students in advanced lightweight materials and manufacturing technologies for automotive and related sectors.

Pay-offs: Low-cost composite materials and lightweight castings and fabrication technologies, design and manufacturing of future generation automobiles, mass transit and light, medium and heavy trucks.

UAB GATE PARTNERS
- UAB School of Engineering (Materials Science & Engineering, Mechanical Engineering, Biomedical Engineering, Civil Engineering)
- Alabama Automotive Companies (Honda, Mercedes, Hyundai etc)
- National Composite Center, Kettering, Ohio
- Miles College, Lawson State Community College, Heritage Center
- Small Businesses (Casting, Plastics and Composites Manufacturer’s)
- DOE Oak Ridge National Laboratory
- Society for Plastics Engineers

REPRESENTATIVE GATE STUDENT PROJECTS

- Composite materials processing technologies for automotive & mass transit applications
- Virtual class room, High Speed Computation and Modeling
- Long Fiber Thermoplastics – Processing & Performance Evaluation
- Automotive Castings Technologies
- Thermofoming and Process Simulation
- Composite Guardrails for Highway Safety
- Modeling of crash & protective padding
- Focus on lightweight automotive technologies

Graduate Automotive Technology Education (GATE) Program

Managed by UT Battelle for the Department of Energy
Recognition of Work at UAB

• UAB featured in front page article on Lightweight Materials Technologies – Composites Technology Magazine
• Featured in JEC Composites magazine, Europe
Alabama Composites Conference at UAB - Focal areas; Energy Efficient Transportation, Defense, Infrastructure, Aerospace and Emerging Technologies – Held every 2 years - About 350 participants attend this meeting

Expanding Avenues – STRUCTURAL COMPOSITES APPLICATIONS IN DEFENSE, TRANSPORTATION, POWER INDUSTRY, ENERGY & INFRASTRUCTURE
University of Alabama at Birmingham (UAB) Campus, Birmingham, Alabama
UAB is working on lightening the loads and improving performance for the soldier.

- **Vest**
- **Helmet**
- **SAPI Plates**
- **ALICE Ruck Sack Frame**
- **Elbow & Knee Pads**
- **Shoulder & Bicep Guards**
UAB has been working on Thermoplastic Composites for Vehicle Protection

Thermoplastic composites armor developed by UAB has the potential to provide materials with high damage tolerance to static and dynamic loads, durability, easy repair ability, high-throughput production and economies of scale.

- Superior multi-hit capability
- Mass produceable in various sizes
- Conformable to various shapes and geometries
- Superior ballistic resistance at low areal densities
A range of material forms can be utilized in MPAD processes

- Long Fiber Pellets
- Unidirectional Tapes
- Woven Thermoplastic Prepregs
Thermoplastic Composites for Mass Transit Applications: UAB has demonstrated 30-60% cost and weight savings on mass transit components such as bus seat, floor segments, roof and side access doors, frame and body panels....
Mass Transit Components Developed

- 2-passenger bus seat
- AC Roof Cover
- Side Body and Frame Segments
- Battery Access Door
- Floor Segment
Highlights of Mass Transit Lightweighting

• Innovation in materials, processing and design of thermoplastic composite technologies for mass transit parts

• Close working ties with industrial partners – Relevant to industry & technology transition

• Technology developed applies to mass transit, light rail, trucks and automotive

• Demonstrated number of mass transit applications from Design concept to Manufactured Prototype – Bus Seat, Floor Segment, Side Body and Frame Panels, Battery Box Access Door, Air Conditioning Roof Cover Door

• 30+ research publications (peer-reviewed journals, international and national conferences)

• 12 graduate students, 20 undergraduate students, 4 staff members, 5 faculty members contributed over the 5-year period
Modeling & Simulation

High Performance Computing

512 Processors
1.5 TFlops

Visualization

Modeling & Simulation

Process Modeling
Crash Modeling

Computational Biomechanics Modeling
Other Application Projects
- Composites focus

Bridges

Navy Systems

Construction

Shelters

Waterfront Structures