Materials and Process Technology Area Snapshot

- Carbon fibers
- Lab-scale intermediates and composites prototyping
- Recycling
- Nondestructive evaluation (NDE)
- Materials characterization

Carbon Fiber Technology Facility

ORNL: US leading neutron characterization and computing power

CO
- Thermo-plastic-glass-carbon recycling
- Factory floor NDE
- Full-scale molding with LCCF
- Pultruded spar caps

IN
- Product lifecycle modeling
- Process modeling for lab-scale validation

KY
- Largest open access solution spinning lab in US

MI
- Closed loop recycling
- Factory floor NDE
- Full-scale preforming
- Molding processes with LCCF

OH
- Factory floor NDE
- Full-scale preforming and winding processes with LCCF

Nonwovens Research Lab
Polymer AM Cell
Wide area flaw detection
Robotic preformer
Largest open access solution spinning lab in US
Thermo-plastic-glass-carbon recycling
Factory floor NDE
Full-scale molding with LCCF
Pultruded spar caps
Product lifecycle modeling
Process modeling for lab-scale validation
Largest open access solution spinning lab in US
Closed loop recycling
Factory floor NDE
Full-scale preforming
Molding processes with LCCF
Factory floor NDE
Full-scale preforming and winding processes with LCCF

Institute for Advanced Composites Manufacturing Innovation
M&P Technology Area engages market leading members

Recycling
US leaders in CF recycling

Fibers
World’s largest PAN fiber source and leading US furnace manufacturer for CF; top 3 US glass fiber producers

Resins
World Leading Thermoplastic & Thermoset Resin Providers

Institute for Advanced Composites Manufacturing Innovation
IACMI Goals as stated in the Funding Opportunity Announcement

Focus Areas
- Vehicles
- Wind Turbine Blades
- Compressed Gas Storage (CNG, Hydrogen)

Five Year Technical Goals
- 25% lower CFRP cost
- 50% reduction in CFRP embodied energy
- 80% composite recyclability into useful products

Impact Goals
- Enhanced energy productivity
- Reduced life cycle energy consumption
- Increased domestic production capacity
- Job growth and economic development

These goals depend on materials and processing technology developments
25% lower CFRP cost demands lower CF cost!

CFRP cost build-up for a van door inner with intrusion beam. Source: Rocky Mountain Institute

Cost breakdown for 700-bar CFRP H2 storage tank. Source: Strategic Analysis
50% reduction in CFRP embodied energy requires attention to CF

Energy Embodied in HP-RTM Composite with 61 wt% CF

Source: ORNL
Achieving 80% composites recyclability

Current ROM estimated recycling rates (all “downcycling”):

- ~ 100k tpy CFRP production; > 10k tpy scrap & < 1k tpy recycled; negligible EOL
- ~ 9M tpy GFRP production; ~ 500k tpy scrap; ~1M tpy EOL, 10 - 80% recycled

Near-term focus on recycling waste from CFRP production scrap
Mid-term we will add end-of-life composite structures

Key challenges:

1. Strong value proposition for GFRP recycling
2. Collection, sorting, classification, separation
   End of life materials often lack a known pedigree and include metals, electronics, etc.
3. Fiber reclamation
   Current technologies at TRL 5 – 8 based on: mechanical recycling, chemical recycling, solvolysis, and pyrolysis
4. Delivering many life cycles of high value intermediates and components in high volume manufacturing
IACMI has unique precursor and carbon fiber processing capabilities

World’s largest university-based solution spinning lab

Melt spinning

Bench and pilot scale heat treatment equipment

World’s most flexible carbon fiber semi-production facility
Highlighted M&P Composites Fabrication

• Lab scale
  – Compounding
  – Weaving
  – Prepregging
  – Injection molding
  – Compression molding
  – Thermoforming

• Full scale
  – Robotic preforming
  – 3D printing
  – Filament winding
  – Pultrusion
IACMI recycling capabilities

MIT-RCF’s slurry preforming (top) and roll goods (bottom) production in its commercial carbon fiber recycling facility

Photos courtesy of Adherent Technologies and MIT-RCF
NDE Overview

• We apply NDE data to help meet IACMI metrics for speed and yield by closing the loop around process design and control.

• We deploy our NDE capabilities where and when needed across the supply chain and product lifecycle.
IACMI Characterization

- Mechanical and physical properties, stress-life testing, fatigue behavior, durability, environmental conditioning
- Multi-Scale and high resolution microscopy, spectroscopy, diffraction/scattering, residual stress and imaging
- Premier polymer characterization facilities for molecular weight and distribution, conformation, size, and thermal properties
- Advance fiber characterization using FTIR, NMR, XPS

Multi-Scale, Multi-Modal Process-Property Relationship & Durability

Automotive Crashworthiness

Material Joining Characterization

Assemblies

Products

Structural monitoring

Components

Composites

Precursors

Carbon Fibers

Interface/interphase shear with resin

Multi-axial static & fatigue behavior

Single Carbon Fiber Nano-Tensile Testing

Institute for Advanced Composites Manufacturing Innovation
Materials and Processing POC’s

Doug Adams (NDE)
douglas.adams@vanderbilt.edu
615-322-2697

Cliff Eberle (M&P)
eberlecc@ornl.gov
865-574-0302

Soydan Ozcan (Recycling)
ozcans@ornl.gov
865-241-2158

Dayakar Penumadu
Materials characterization
dpenumad@utk.edu
865-974-2503

Matt Weisenberger
Solution Spinning
matt.weisenberger@uky.edu
859-257-0322