U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Welcome!

Fiber Reinforced Polymer Composite Manufacturing Workshop

January 13, 2014

Mark Johnson

Director

Advanced Manufacturing Office

manufacturing.energy.gov

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Breakout Instructions

January 13, 2014

Mark Johnson

Director

Advanced Manufacturing Office

manufacturing.energy.gov

Breakout Objectives

Let's dig deeper:

- **Manufacturing Process Technologies - Blue Teams A and B** (e.g. lay-up techniques, out of the autoclave, novel cure techniques, resin infusion, pultrusion, SMC, tooling, machining)
- **Enabling Technologies and Approaches - Red Team** (e.g. design methods and databases, analytical tools, nondestructive evaluation, damage tolerance, joints, repair, other)
- **Recycled and Emerging Materials - Green Team** (e.g. recycling carbon fiber, renewable precursor materials, advanced glasses, nanomaterials)

EERE 5 Core Questions

- **Impact:** Is this a high impact problem?
- **Additionality:** How will EERE make a significant difference relative to what other entities are doing?
- **Openness:** Are we focusing on the broad problem we are trying to solve and open to new ideas, new approaches and new performers?
- **Enduring Economic Benefit:** Will this result in enduring economic benefit to the United States?
- **Proper Role of Government:** Why is what we are doing a proper high impact role of government versus something best left to the private sector to address on its own?

Main R&D Areas for Low-Cost Composites

- **Manufacturing throughput** without degrading performance
- **Energy use** for composite materials and structures fabrication
- **Recyclability** for both in-process scrap and end-of-use.
- **Enabling technologies and approaches** to support improvements to composite manufacturing.

Proposed Objectives for Composites

- **Cost:**
  - Reduction of the production **cost of carbon fiber composites** for targeted applications (vehicles, wind, high-pressure gas storage) **by >25% in five years**, on a pathway to a reduction of **cost >50% over 10 years**;*
- **Energy:**
  - Reduction **of life cycle energy and greenhouse gas emissions** by more **than 50% for fiber reinforced polymer composite applications** over a ten year time frame;*
  - **Reduction of the embodied energy** and associated greenhouse gas emissions of carbon fiber composites **by 50%** compared to today's commercial **thermoplastic** technology and **75%** to today's commercial **thermoset** technology **in five years**; and
- **Recyclability:**
  - Demonstration of innovative technologies at sufficient scale for **80% recyclability of both glass and carbon fiber** reinforced polymer composites **in five years**, and **>95% in ten years** into useful components with projected cost, quality and production volumes at commercial scale competitive with virgin materials.

Application Areas and CFC Targets

Application	Current CFC Cost	CFC Cost Reduction (2018)[1]	CFC Ultimate Cost[a,b]	CFC Tensile Strength[c]	CFC Stiffness[c]	Production Range/Cycle Time
Vehicles (Body Structures)	$26-33/kg	35%	<$11/kg by 2025[63] ~60%	0.85GPa[d] (123ksi)	96GPa[d] (14Msi)	100,000 units/yr <3min cycle time (carbon) <5min cycle time (glass)[63,64]
Wind (Blades)	$26/kg	>25%[64]	$17/kg ~35%	1.903 GPA (276ksi)	134GPa (19.4Msi)[67]	10,000 units/yr (at >60m length blades using carbon fiber)[64]
Compressed Gas Storage (700 bar – Type IV)	$20-25/kg	30%[64]	$10-15/kg ~50%[68]	2.55 Gpa (370ksi)	135 Gpa (20Msi)[69]	500,000 units/yr (carbon fiber)[64]

Key Questions

- Identify a **specific key technology** that has the potential to help achieve these objectives and the **target application areas** or whether the technology is cross-cutting.

- What is the **state of the art** for this technology? Notional Technology Readiness Level/Manufacturing Readiness Level (TRL/MRL) - basic research, applied, pilot scale, commercial?

- What are the **current limitations/challenges** to this technology, in particular …for use in clean energy and industrial applications? …that prevents industry from doing this on their own?

Report Out - Example

Identified Technology	Application Area	State of the Art	Limitations/ Challenges
ICME - Integrated Computational Materials Engineering The integration of materials information, captured in computational tools, with engineering product performance analysis and manufacturing process simulation.	Cross Cutting	Generally TRL 3-4, with selected (few) examples at TRL 7 and beyond	• Need for open demonstrations of the integrated approach • Democratizing tools and especially integration approaches • Developing open datasets, data management approaches and standards • Growing the small community of specialists trained in ICME techniques

"Don't you need to be like, making something in order to create jobs"

- Neil DeGrasse Tyson