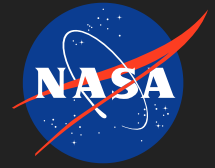


Composite Manufacturing Technologies for Aerospace Performance at Automotive Production Rates

Active Technology Project (2020 - 2024)



Project Introduction

Urban Air Mobility (UAM), a safe and efficient air transportation system for on-demand mobility (ODM) from small package delivery to air taxis, has arrived as the next frontier in air transportation. Market studies have established economic factors with NASA setting forth a Grand Challenge in the 2022 timeframe. With higher production volumes and smaller size than commercial aircraft, studies have identified need for next generation composite materials and manufacturing methods to meet ODM goals of affordability, safety and lifecycle emissions. A new paradigm shift is proposed to innovate highly aligned short fiber composites that can be stamped like sheet metal at high rate while retaining aerospace properties and tailorability in lightweight composite structures.

The University of Delaware (UD-CCM) has developed a highly-aligned short fiber-based composite feedstock (>57% volume fraction) that enables automotive-like production processes at high rate (i.e. 1 minute cycle times) with properties equivalent to aerospace-grade continuous fiber composites. Single step metal-like forming of tailored blanks into complex geometries has been demonstrated. An automated pilot facility to convert fibers to parts at rate will be leveraged to create new prepreg and tailored blanks formats for model validation, database generation and forming demonstrations.

The Technical Challenge is to develop a science-based part/process design methodology for *TuFF* composites meeting aerospace performance at automotive manufacturing rates, as well as demonstrate at rate manufacturing capability of *TuFF* complex geometry parts. A combined experimental and modeling approach is leading to *TuFF* composite part design and manufacturing guidelines for industry transition. Modeling aspects will focus on visualizing and understanding fiber-scale mechanisms of alignment during processing, mechanical loading and rate dependent forming of highly aligned short fiber layers, development of experimentally validated constitutive models, process and part design.

Anticipated Benefits

Manufacturing research, technology transition and education of students and workforce represent the major goals of our effort. A NASA Roadmap in manufacturing and integrated structures identified UAM technology requirements over a 15-year timeframe with operational prototypes by 2026, and technology scaling by 2031. The goal of our ULI is to address technology barriers in manufacturing of complex geometry composite parts for UAM and commercial air platforms, meeting aerospace performance at automotive-like production rates, and to transition technology to our industrial partners and the US industrial base.

Our highly aligned short fiber material provides a paradigm shift away from expensive and specialized aerospace technology using continuous fiber



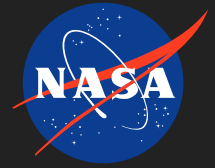
ULI Partners

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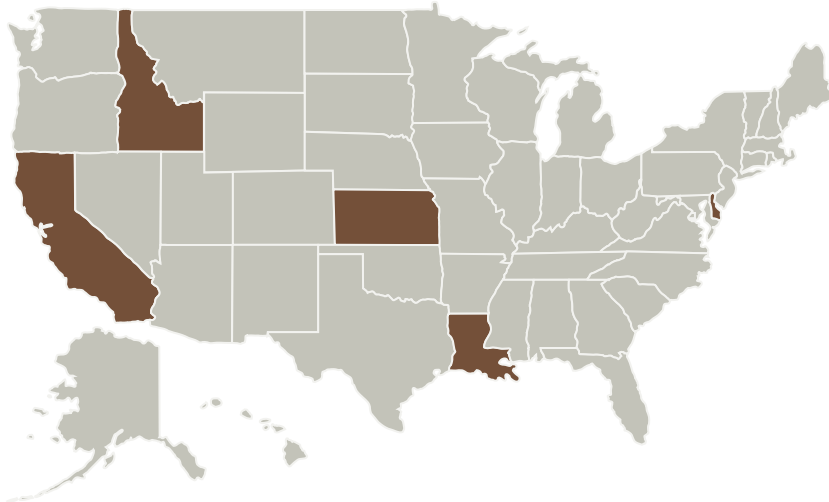
Active Technology Project (2020 - 2024)



composites to a new high-performance short fiber composite that can be designed like metals, stamp-formed like metals and reused/recycled like metals.

Student/workforce education represents a core tenet of the project and will provide opportunities for undergraduate interns, graduate research in composites manufacturing and collaborative training/education opportunities with our HBCU and industry partners. Our team also includes OEM/Tier 1 partners, material suppliers and composites industry supply chain. Annual Open Manufacturing Demonstration events are planned with feature-based, non-proprietary geometries to engage the composites eco-system in the US.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Aeronautics Research Mission Directorate (ARM D)

Lead Organization:

University of Delaware Center for Composite Materials

Responsible Program:

Transformative Aeronautics Concepts Program

Project Management

Program Director:

John A Cavolowsky

Project Manager:

Koushik Datta

Principal Investigator:

John W Gillespie

Co-Investigators:

Shridhar Yarlagadda

Dirk Heider

John Geriguis

Scott Bishop

David Leach

Patrick Mensah

Composite Manufacturing Technologies for Aerospace Performance at Automotive Production Rates

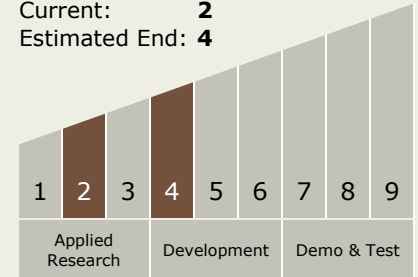
Active Technology Project (2020 - 2024)



Organizations Performing Work	Role	Type	Location
University of Delaware Center for Composite Materials	Lead Organization	Academic	Newark, DE
Advanced Thermoplastic Composites Manufacturing(ATC)	Supporting Organization	Industry	Post Falls, ID
Joby Aviation	Supporting Organization	Industry	
Southern University and A&M College	Supporting Organization	Academic	LA
SpiritAerosystems	Supporting Organization	Industry	

Technology Maturity (TRL)

Start: **2**
 Current: **2**
 Estimated End: **4**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
 - ↳ TX12.4 Manufacturing
 - ↳ TX12.4.2 Intelligent Integrated Manufacturing

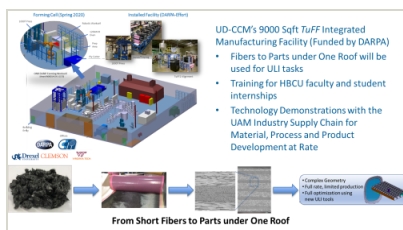
Target Destination

Foundational Knowledge

Primary U.S. Work Locations

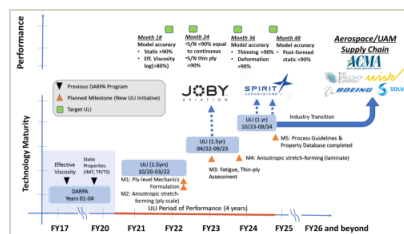
California	Delaware
Idaho	Kansas
Louisiana	

Images



From Short Fibers to Parts under One Roof

From Short Fibers to Parts under One Roof
 (<https://techport.nasa.gov/image/40324>)



TuFF Part/Process Design Methodology

TuFF Part/Process Design Methodology
 (<https://techport.nasa.gov/image/40323>)

Composite Manufacturing Technologies for Aerospace Performance at Automotive Production Rates

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ULI Partners

ULI Partners

(<https://techport.nasa.gov/image/40322>)

Links

Closed Loop Recycling of CFRP Into Highly Aligned High Performance Short Fiber Composites Using the TUFF Process
(<https://doi.org/10.33599/nasampe/s.19.1607>)

Formability of TUFF Composite Blanks
(<https://doi.org/10.33599/nasampe/s.19.1606>)

Microstructural Evaluation of Aligned, Short Fiber TUFF Material
(<https://doi.org/10.33599/nasampe/s.19.1609>)

Tailorable Universal Feedstock for Forming (TUFF): Overview and Performance
(<https://doi.org/10.33599/nasampe/s.19.1605>)

Project Website:

<https://www.ccm.udel.edu/>