



Composites for Space Applications

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Remarks

- ❑ Welcome to Composite Conference 2012
- ❑ Special thanks and welcome to participants in the NASA Composite Summit that started this collaboration.
- ❑ Special Thank You!
 - ❑ Joshua Jackson (MKF), Harold Beeson (NASA), James Fekte (NIST) and Antonio Ruiz (DOE) for chairing the conference
 - ❑ Session chairs and all NASA and NIST staff who worked hard to organize the conference with MKF
 - ❑ New Mexico State DACC's president Dr. Margie Huerta for hosting us in the East Mesa Facility
 - ❑ Angelique Lasseigne (G2M2) Crystal Lay (NMSU Mechanical and Aerospace Engineering) and Charles Nichols (NASA) for making STEM student sponsorship possible.

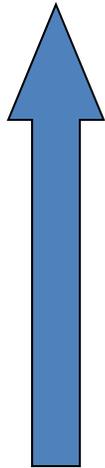
Why are we here?

- Need high strength materials in mass and cost constrained applications
 - Additional knowledge needed to use composites in our applications more efficiently
 - Non-homogenous material
 - Anisotropic structures
 - Viscoelastic response to loading
 - Multiple material interfaces
- Composite use in space systems requires
 - Advanced structural models
 - Life and failure mode prediction
 - Harmonized codes and standards
 - Materials and processes that address composite component variability
 - Reliable nondestructive evaluation

NASA's Use of Composites



Future Composite Space Vehicles (NASA's Composite Crew Module)



Growth in Composite use

Future	NASA Space Technology Roadmaps	Composite is Cross cutting technology, TA12, TA7
Today	NASA's COTS & CCDEV Vehicles	Composite Pressure Vessels Composite Structure
Today	Space Launch System	Composite Pressure Vessels Composite Structure
Today	Orion	Composite Pressure Vessels
1990s	International Space Station	Composite Pressure Vessels
1970s	Space Shuttle	Composite Pressure Vessels Composite Wing Leading Edge
1960s	Apollo	Pre-composites

Crosscutting for Space Technology Roadmaps

- ❑ Composites are a crosscutting technology for NASA's future missions.
 - ❑ Low Earth Orbit Access and Propellant Depots (2015)
 - ❑ Mars Precursor Missions & Heavy Lift Vehicle (2020)
 - ❑ Advanced In-space Propulsion (2025)
 - ❑ Space Platforms (2030)
- ❑ Information on technology roadmaps can be found at:
<http://www.nasa.gov/offices/oct/home/roadmaps/index.html>

Composites Need: Space Technology Roadmap

Capabilities	Selected Mission Architectures	2010		2015		Radiation Protection		NEO/Mars Pre	
		WFIRST	Exploration Science Aeronautics	LEO Access	Propellant Depot N+1	Explorer Augmentation			
2.1 Materials									
2.1.1 Lightweight Structure				Non-autoclave Composite ★		Hybrid Laminates ▲		Tailorable (spec. strength, therm. Cond.) ▲	
2.1.2 Computational Design				Micro Design Models ▲		PMC Damage Models ▲		Environment (time dependent degradation) ★	Phy
2.1.3 Flexible Material Systems						Expandable Habitat ▲		Flex. EDL Materials ★	
2.1.4 Environment						Cryo-Insulators ▲		Ad. Ablator ▲	Radiation/MMC ▲
2.1.5 Special Materials						Optical Materials (windows) ▲		Repair ▲	Sensor Materials ▲, Space Suits ▲
2.2 Structures									
2.2.1 Lightweight Concepts				Non-Autoclave Primary Struct. ★		Composite Cryo Tanks ▲		Probabilistic Design Methodology ★	Composite/Infl ★
2.2.2 Design and Certification Methods				Streamlined DAC Processes ▲		Composite Allowables ▲		High-fidelity Response Simulation ★	
2.2.3 Reliability and Sustainment				Predictive Damage Methods ▲		Life Extension, Prediction ▲		SHM, THM Integration ★	
2.2.4 Test Tools and Methods				Integrated Flight Test Data ID and Usage ▲		Full-field Data Acquisition (non-contact) ★		Full-field Model V&V ★	Active Co of Struct. ★
2.2.5 Innovative, Multifunctional Concepts				Integrated Cryo tank ▲		Integrated (non-pres) MMOD ★		Reusable Modular Components ▲	Integrated Window ▲, Inte. Radi. ★
2.3 Mechanical Systems									
2.3.1 Deployables, Docking and Interfaces				Common Universal Interchangeable Interfaces ▲		Restraint / Release Devices ▲		Deployment of Flex Materials ▲	Large Lightweight Stiff Dep. ▲
2.3.2 Mechanism Life Extension Systems						Long Life Bearing/ Lube Systems ▲		Cryo Long Life Actuators ▲	
2.3.3 Electro-mechanical, Mechanical and Micromechanisms				Robotic Assembly Tools/Interfaces ▲		Cryogenic and Fluid Transfer ▲		Active Landing Attenuation System ▲	
2.3.4 Design and Analysis Tools and Methods						Kinematics & Rotor Dynamics Analysis ▲			Precursor Flight High Rate Data for Design
2.3.5 Reliability / Life Assessment / Health Monitoring				Relevant Environment Durability Testing (i.e.ISS) ▲				Embedded Systems ★	Life Extensio. ▲
2.3.6 Certification Methods				Loads & Environments ▲		Test Verified Physics ▲		Predictive Damage Methods ▲	
2.4 Manufacturing									
2.4.1 Manufacturing Processes						PMC & MMC Processes ▲		CMC Processes ★	

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Accelerated Growth in Composites

- ❑ Barriers to Growth
 - ❑ Funding limitations
 - ❑ Cross disciplinary technological challenges
 - ❑ Maturity required to meet roadmap dates
- ❑ Steps to Accelerate Growth
 - ❑ U.S. intra-government collaboration
 - ❑ Government-industry partnerships
 - ❑ International communication and collaboration
 - ❑ Globally harmonized roadmaps for key technologies



NASA-Commercial Collaboration
Charlie Bolden (NASA) and
Elon Musk: (Space X)

Composite Conference 2012

Let's Go!

- Address the global challenge of using composites in our applications by addressing common issues
- Excited to meet with leaders who are advancing composites in their applications
- Keep up with a paradigm shift from metals to composites occurring in aerospace, automotive, marine, and pipelines

www.compositeconference.com