MULTIFUNCTIONAL STRUCTURES FOR HIGH-ENERGY LIGHTWEIGHT LOAD-BEARING STORAGE

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Overview/Description

Efforts in Multifunctional Structures for High Energy Lightweight Load-bearing Storage (M-SHELLS) are pushing the boundaries of development for hybrid electric propulsion for future commercial aeronautical transport. The M-SHELLS hybrid material would serve as the power/energy storage of the vehicle and provide structural integrity, freeing up usable volume and mass typically occupied by bulky batteries. The ultimate goal is to demonstrate a system-level mass savings with a multifunctional structure with energy storage.

Partners

NASA Glenn Research Center  •  NASA Langley Research Center  •  NASA Ames Research Center
• University of Cincinnati  •  Case Western Reserve University

Recent Results/Status

• Assembled four configurations based on modeled honeycomb and corrugated concepts—tested for structural integrity and downscaled to two honeycomb configurations
• Scale-up of electrodes and electrochemical structural components
• Developed and tested building block ribbons and techniques for electrochemical/mechanical ribbon assembly
• Calculated positive multifunctionality for M-SHELLS concept
• Electrochemical/mechanical properties were successfully calculated within 25% of experimental values
• Models developed will streamline the screening of future chemistries and designs for multifunctional structures

Feasibility Assessment and Benefits

Feasibility Assessment:
• Use advanced materials and designs to develop multifunctional structural load-bearing energy storage
• Development of hybrid supercapacitor chemistries and advanced nanomaterials to meet power and energy needs with improved mechanical performance
• Structural designs that best utilize the properties of multifunctional energy storage materials
• Demonstrate multifunctional load-bearing energy storage materials in a flight demonstration with system-level weight benefit

Benefits:
• Enable big leaps in efficiency and environmental impact
• Provide significant overall system mass savings

Next Steps

• Continued scale-up of electrodes and electrochemical structural components
• Continued multifunctional performance characterization
• Continued utilization of performance and multi-physics models
• Assessment of suitability of advanced next-generation battery components within structural designs
• Continue co-ops and flight planning for demonstration flight integration of multifunctional structure into Tempest UAV