National Aeronautics and Space Administration

# MULTIFUNCTIONAL STRUCTURES FOR HIGH-ENERGY LIGHTWEIGHT LOAD-BEARING STORAGE

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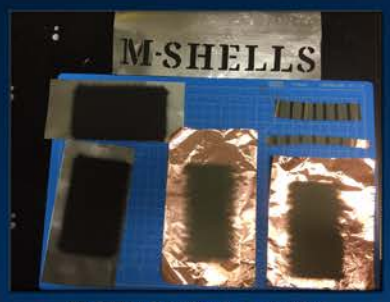
## Overview/Description

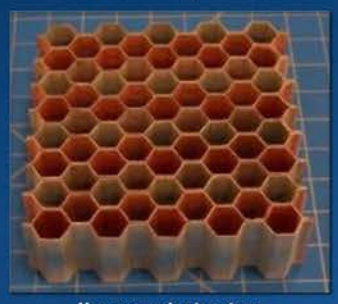
Efforts in Multifunctional Structures for High Energy Lightweight Load-bearing Storage (M-SHELLS) are pushing the boundaries of development for hybrid electric propulsion for future commercial aeronautical transport. The M-SHELLS hybrid material would serve as the power/energy storage of the vehicle 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.



M-SHELLS custom electrodes

M-SHELLS ribbon cell with in-house designed corrugation tools

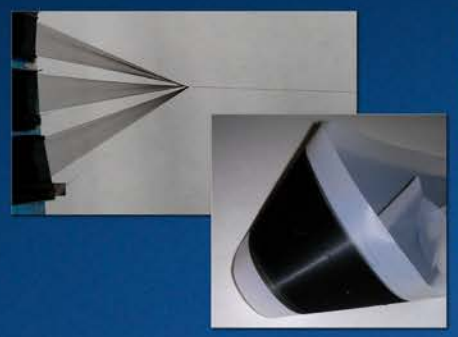

Corrugated honeycomb building block

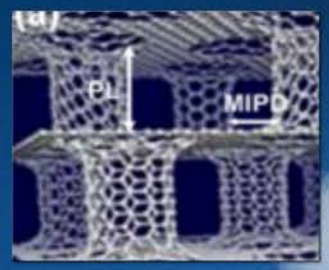

Honeycomb structure

## 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 downselected 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 con-ops and flight planning for demonstration flight integration of multifunctional structure into Tempest UAV

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