ARMD Transformative Aeronautics Concepts Program

CONVERGENT AERONAUTICS SOLUTIONS PROJECT

Multifunctional Structures for High-Energy Lightweight Load-bearing Storage

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PI (GRC)

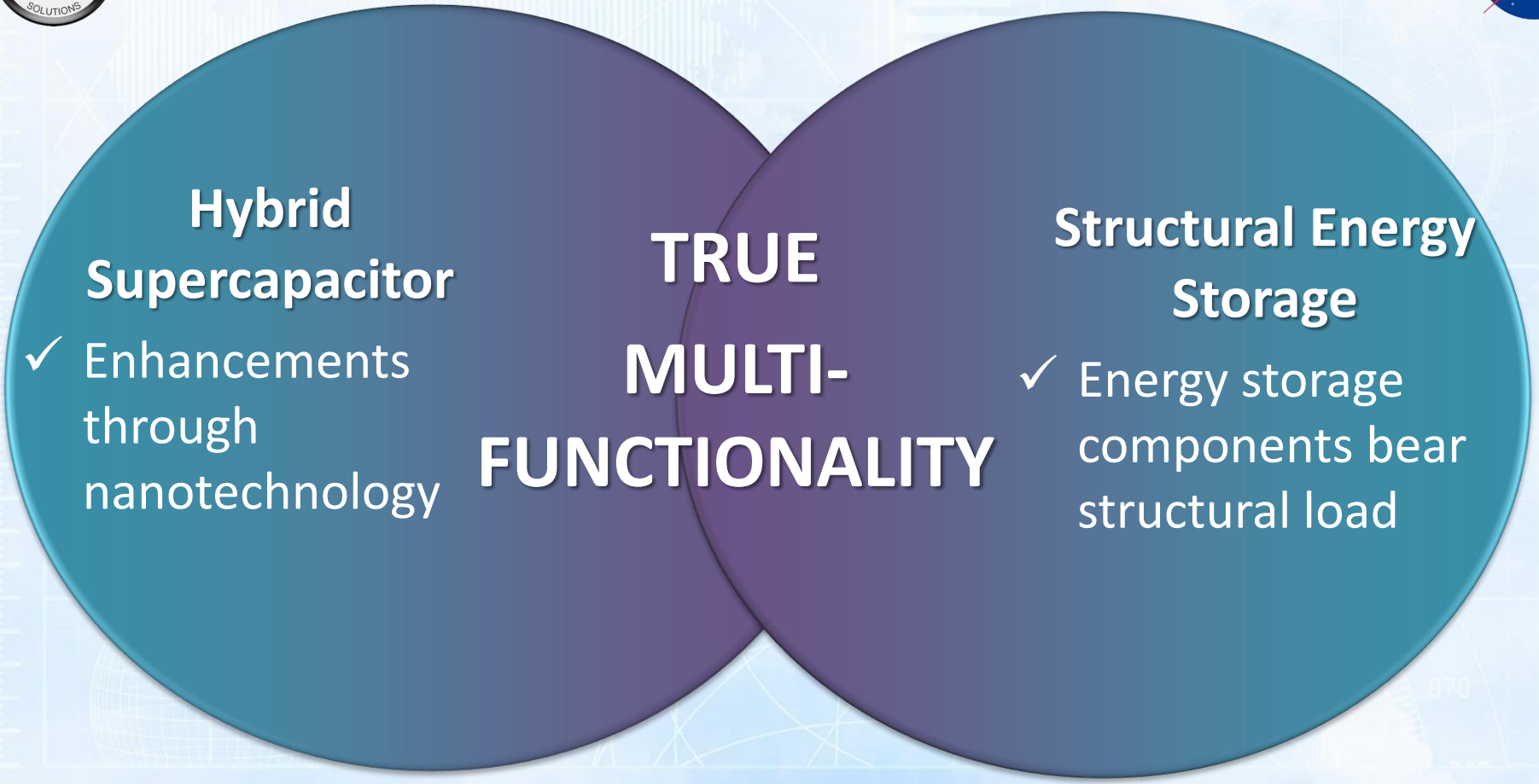
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Co-PI (LaRC)

Contents

- M-SHELLS Overview
  - Project Summary
- M-SHELLS Team
- MSHELLS Concept
  - Battery-supercapacitor hybrid development
  - Structural energy storage development
  - Multifunctional design, analysis & demonstration
- System Benefits
- Failures & Challenges
- Next Steps

But How?


Hybrid Supercapacitor
✓ Enhancements through nanotechnology
TRUE MULTI-FUNCTIONALITY
Structural Energy Storage
✓ Energy storage components bear structural load

M-SHELLS Team

- Ceramic and Polymer Composites (GRC)
- Materials Chemistry & Physics (GRC)
- Multiscale & Multiphysics Modeling (GRC)
- Environmental Effects & Coating (GRC)
- PV & Electrochemical Systems (GRC)
- Power Architecture & Analysis (GRC)
- Thermal Protection Materials (ARC)
- Case Western Reserve University
- University of Cincinnati

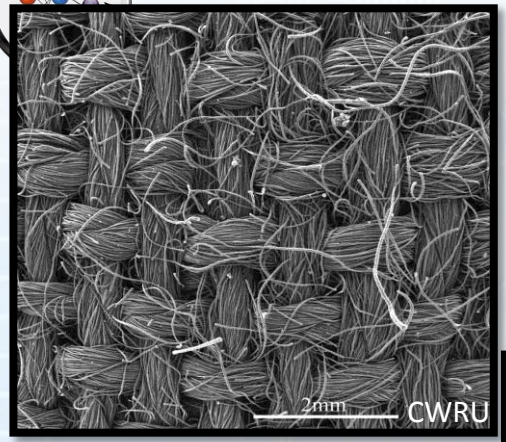
- Aeronautics Systems Analysis (LaRC)
- Structural Mechanics & Concepts (LaRC)
- Structural Dynamics (LaRC)
- Advanced Materials & Processing (LaRC)
- Aeronautics Systems Engineering (LaRC)
- Mechanical Systems (LaRC)
- Structural & Thermal System (LaRC)
- Fabrication Technology Development (LaRC)
- UAS Operation Office (LaRC)

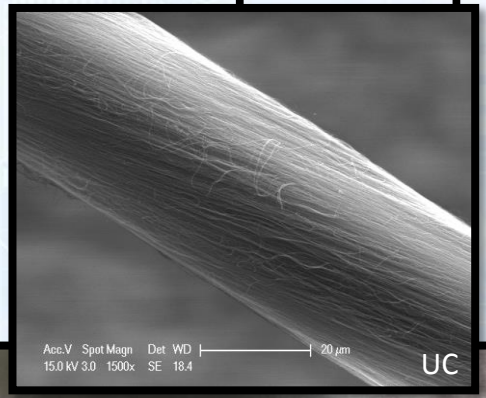
Plus many NASA Co-ops & interns

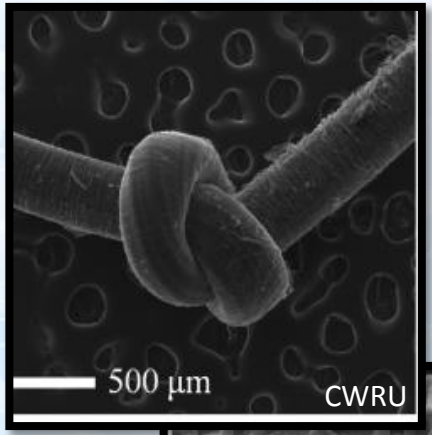
Next-Generation NASA Engineers Developing Next-Generation Materials

- Validation of next-generation materials found in literature
- Development of sealing techniques for cells
- Optimization of electrode materials to improve energy and power density
- Experimentation with advanced electrode manufacturing/scale-up procedures
- Continued development of next-generation structural energy storage components
- Modeling of mechanical and electrochemical properties, and systems analysis, for hybrid structural energy storage systems

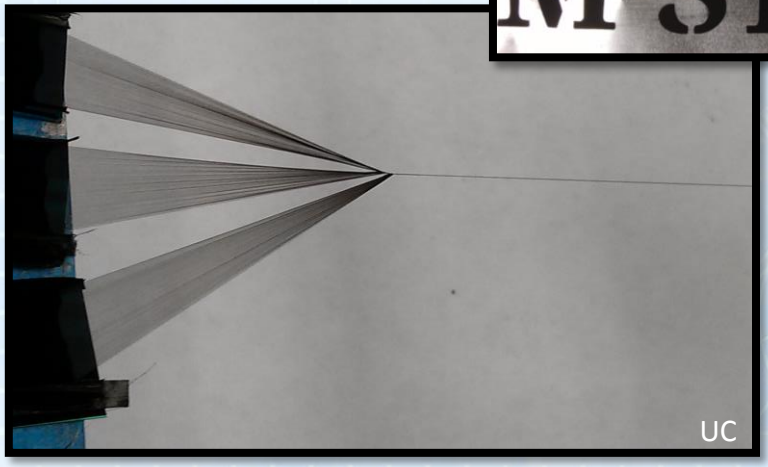
Hybrid Supercapacitor

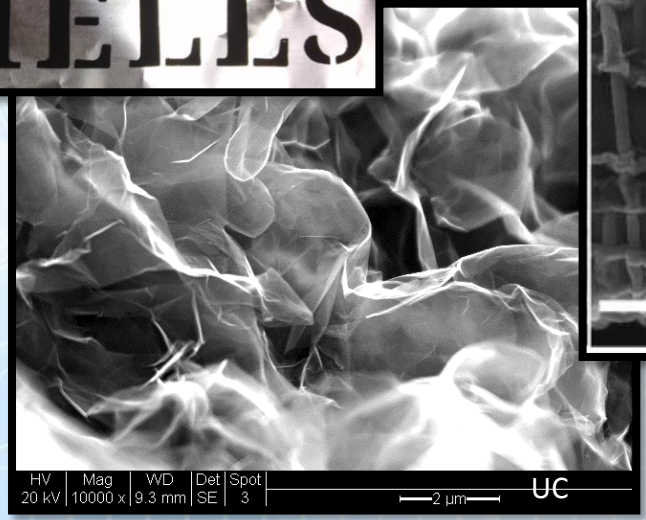


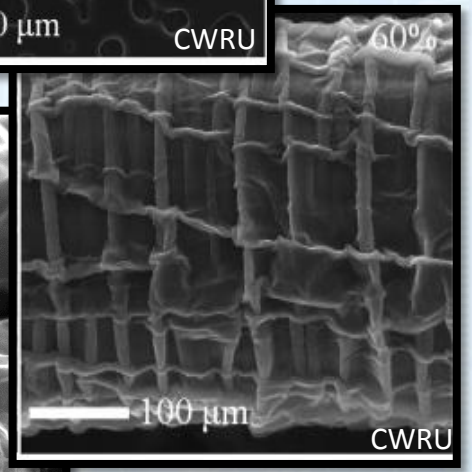




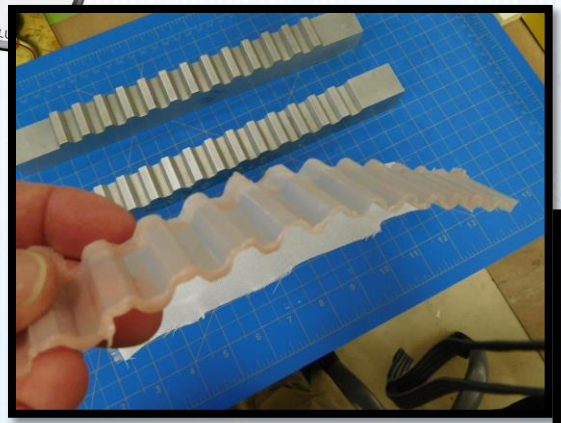


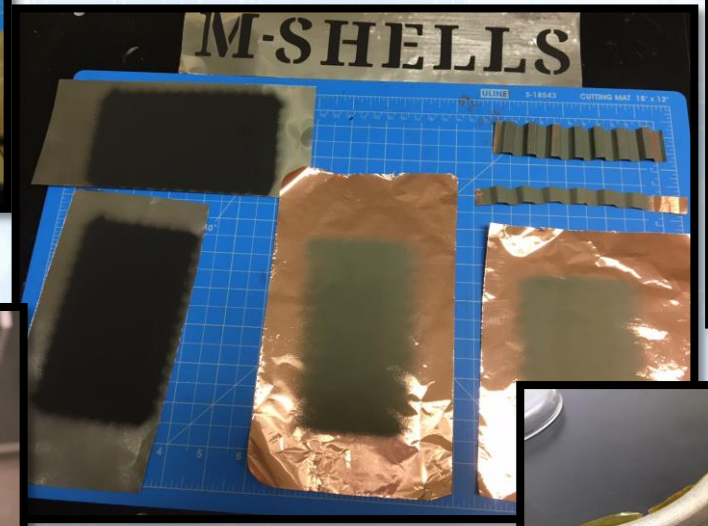


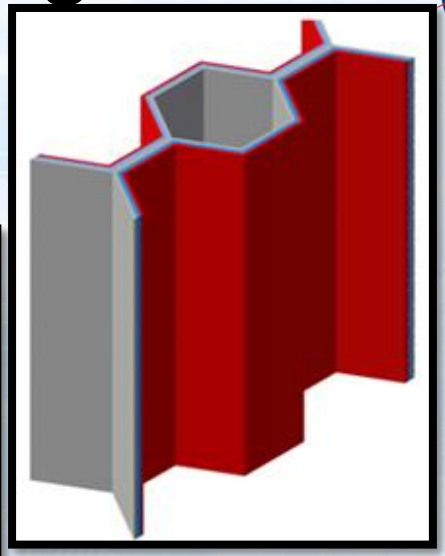


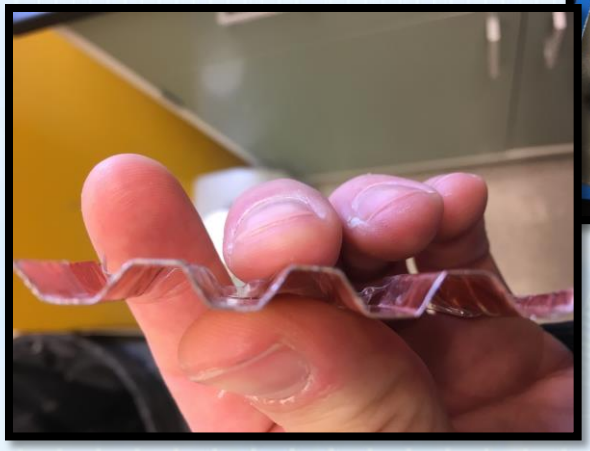


Structural Energy Storage



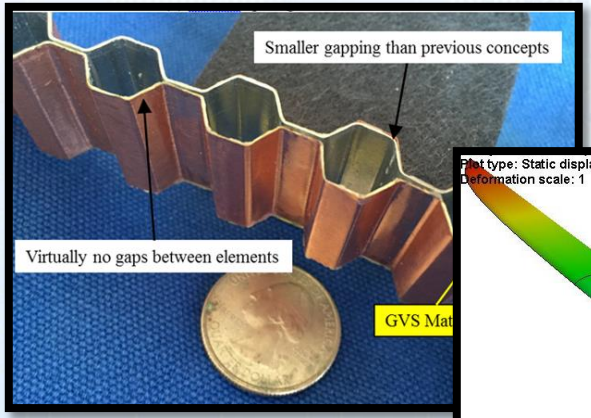


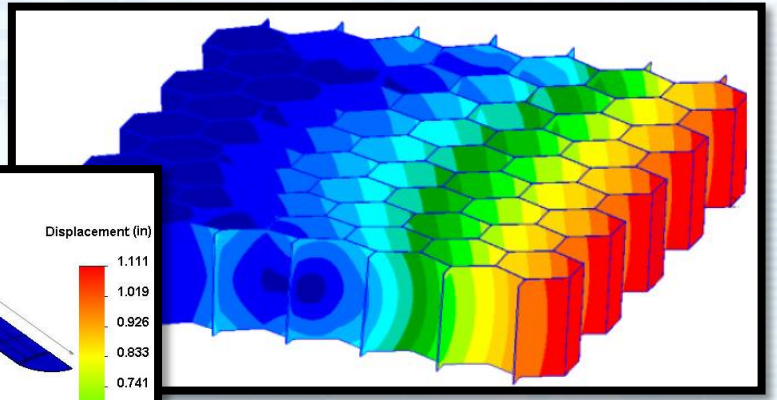


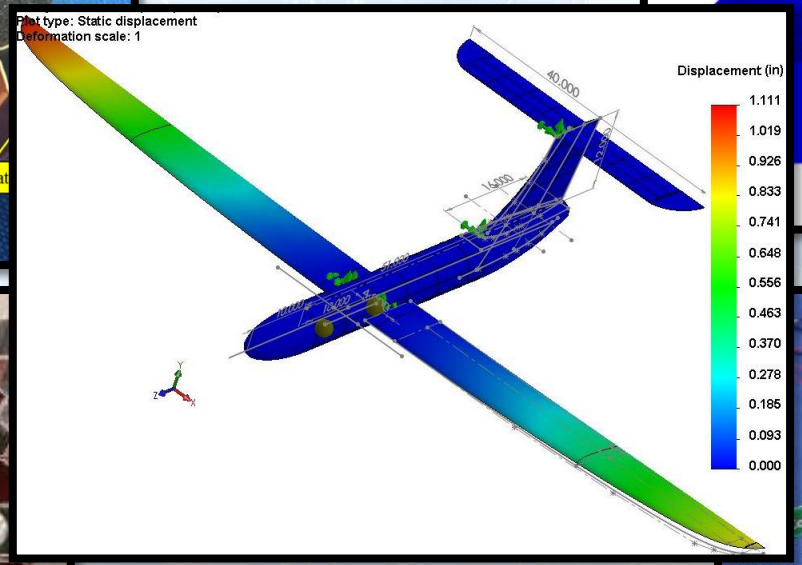


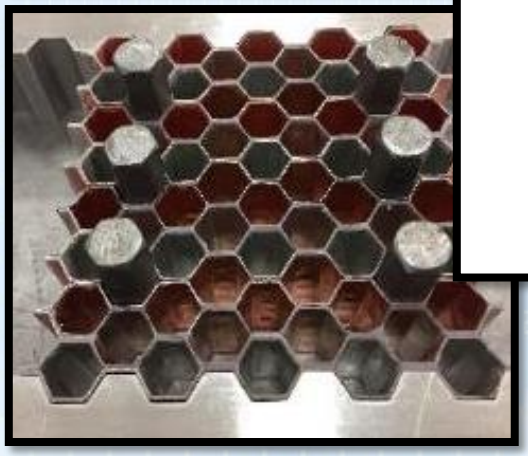


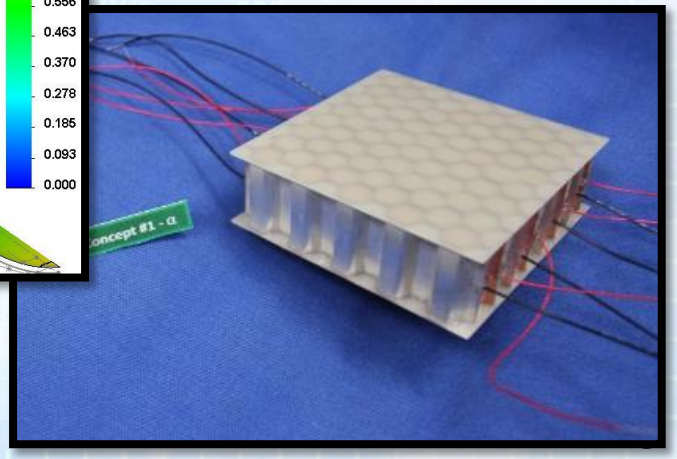
Multi-functionality







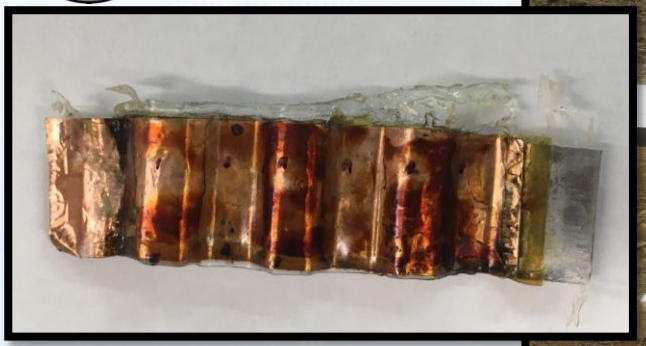




System Benefits

- Lighter-weight battery/structure combination
  - Positive multifunctional mass savings
- Hybrid = faster charge time
- “Free energy” stored within airframe
- Not limited to aircraft structure integration
  - You can put it in the seats, you can put it in the floor, put it in the ceiling, or why not a door?

Failures & Challenges













Next Steps

- Continued development and adoption of next-generation structural materials
  - Nanowire, structural separator/electrolyte, composites
- Advanced structural designs and systems modeling/analysis
- Additive manufacturing