High Density Energy Storage for Space Missions

Name of Technology:
Energy Density of Low Cycle Life Energy Storage

Participating NASA Centers:
GRC (Lead); GSFC, JPL, JSC, MSFC

Technological Area:
E2.05 Energy Storage Technologies

Vision for the Technology:
Exploration missions to the moon, Mars, and other locations will require energy storage systems to endure long periods of dormancy and periods of long-term usage. Spacecraft and rovers will need space-rated energy storage systems with specific energy (>300 W-Hrs/kg) with long discharge periods (>10 hours). Charging and discharging cycles will be based on the vehicle's eclipse periods when solar arrays can't supply power.

Challenges:
Currently, energy storage technologies are using low temperature cell chemistry to achieve 200 W-Hrs/kg. This will result in requiring more and/or heavier batteries with shorter missions.

Battery energy storage with high specific energy of greater than 300 W-Hrs/kg will be required for rovers and other applications to be able to function throughout the day. Otherwise, it will limit the crews from performing their daily missions.

Energy storage systems must be able to operate in extreme temperatures during all periods of the mission. Lunar missions span from -230° C to +120° C while a missions to Venus would span 400° C to 500° C.

NASA Seeks to Meet the Following Specs:
Successful closure of this gap will be determined through:

- Mid-range goal energy storage using low temperature cell chemistry, Li metal cells, thermal insulation, and wireless power charge/discharge to achieve 300 W-Hrs/kg
- Far-range goal energy storage using same technology as mid-range with increased cell specific energy to achieve >400 W-Hrs/kg
- Alternative energy storage solutions with greater than 300 W-Hrs/kg

Overview of Student Project:
NASA seeks innovative energy storage systems to power spacecraft, rovers, and other applications that require periods of long-term usage. Spacecraft and rovers will need space-rated energy storage systems with specific energy greater than 300 W-Hrs/kg with long discharge periods of greater than 10 hours.

Innovative Areas Student Projects Can Address:

- Improvements in energy density and specific energy
- Improvement in cycle life, run time, and calendar life
- Performance over a wide temperature range
- Reduction in device size, to the micro-scale
- Reduction in system complexity
- Integration into, and with, other spacecraft structures

In addition to batteries, NASA is interested in other advanced energy storage technologies designed to the above mission requirements, such as:

- Flywheels
- Supercapacitors
- Magnetic energy storage
- Others

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Project Phases

I. Conceptual and feasibility study with characteristics

II. Proof of Concept/Prototype in lab environment

Research Funded by NASA on this Topic:

Proposal Number: 12-1 S3.04-9198
High Energy Density, High Power Density, High Cycle Life Flywheel Energy Storage Systems

Proposal Number: 16-1 S3.06-7615
High Efficiency Hybrid Energy Storage Utilizing High Power Density Ultracapacitors For Long Duration Balloon Flights

Proposal Number: 09-1 X7.01-9228
Novel Lithium Ion High Energy Battery

Proposal Number: 14-1 S3.03-9142
High Energy Density Lithium Battery System with an Integrated Low Cost Heater Sub-System for Missions on Titan.

Proposal Number: S4.07-9679
Long Life, High Energy Silver/Zinc Batteries

References:

E2.05Energy Storage Technologies

X3.02Energy Storage

T6.01Safe High Energy Density Batteries and Ultracapacitors

S3.03Power Electronics and Management, and Energy Storage

S3.04Power Electronics and Management, and Energy Storage

S13.07Energy Storage for Extreme Environments

H8.02Ultra High Specific Energy Batteries