S4.04 Deep Space Power Systems

Lead Center: GRC

Participating Center(s): GSFC, JPL, JSC

Innovative concepts using advanced technology are solicited in the areas of energy conversion, storage, power electronics, and power system materials. Power levels of interest range from tens of milliwatts, to hundreds of watts. NASA Space Science missions in deep space environments require energy systems with long life capability, high energy density, high radiation tolerance, reliability, and low overall costs (including operations) which can operate in high and low temperatures and over wide temperature ranges. Advanced technologies are sought in the following areas:

Energy Conversion

Advances in photovoltaic technology are sought, including high power solar arrays and ultra lightweight thin and concentrator arrays with substantial increases in specific power watts per kilogram. Advances in radioisotope power conversion to electricity (tens of milliwatts to hundreds of watts with efficiencies >20 %) are sought. This includes advances in thermophotovoltaics, thermoelectrics, and Stirling. All proposed energy conversion technologies must be able to operate in deep-space environments with high radiation and wide-temperature operations.

Energy Storage

Includes advances in primary and secondary (rechargeable) battery technologies. Rechargeable technologies include lithium ion batteries, lithium polymer batteries, and other advanced concepts providing long life capability, and dramatic increases in mass and volume energy density watt hours per kilogram and watt hours per liter. Primary battery technologies include Li-CFx and other high specific energy electrochemical systems. Must be able to operate in deep-space environments, including high radiation and low (-100°C) to high (400°C) temperature regimes.

For operation on planetary surfaces, the use of regenerative fuel cells, both conventional and unitized - passive designs, with substantial increases in mass and volume-specific energy for those situations where there are substantial time periods of charging and recharging (anywhere from hours to days).
Power Electronics

Advanced power electronic materials and devices for deep-space power systems are sought. The materials of interest include soft magnetics, dielectrics, insulation, and semiconductors. Devices of interest include transformers, inductors, electrostatic capacitors, high power semiconductor switches and diodes, and integrated control and driver circuits. Proposed technologies must improve upon the following characteristics: high temperature operation (>200°C), low-temperature (cryogenic) operation, wide-temperature operation (25–200°C), and/or high levels of space radiation (>150 krad) resistance.

Electronics Packaging

Advanced electronics packaging technologies that reduce volume and mass capable of either high temperature or wide temperature operation and space radiation resistance for use in space power systems are of interest. Also of interest are thermal control technologies of high heat flux capability which are integral to the electronic package.

Power System Materials

Advances are sought in materials, surfaces, and components that are durable for soft x-ray, electron, proton, and ultraviolet radiation and thermal cycling environments, lightweight electromagnetic interference shielding, and high-performance, environmentally-durable thermal control surfaces.