NASA SBIR 2014 Phase I Solicitation

H5.02 Deployable Structures

Lead Center: LaRC

Participating Center(s): GRC, JPL

Nearly all spacecraft flown to date are powered by deployable solar arrays, having up to 100 m^2 of solar cell area and 25 kW of electrical power. NASA has a vital interest in developing much larger arrays over the next 20 years with up to 4000 m^2 of deployed area (1 MW) for exploration missions using solar electric propulsion (SEP). Scaling up solar array deployed surface area by more than an order-of-magnitude will require game changing innovations. In particular, novel flexible-substrate designs are needed that minimize structural mass and packaging volume while maximizing deployment reliability, deployed stiffness, deployed strength, and longevity. Most of the mass savings in these very large future arrays will probably come from improvements to solar array supporting structures, not from improvements in the solar cells mounted on the arrays.

NASA is currently developing solar array systems for SEP in the 30-50 kW power range. This SBIR subtopic seeks innovative structures and materials technologies and capabilities for the next generation of lightweight solar arrays beyond 50 kW. Technologies are needed for the design and verification of large deployable solar arrays with:

- 200-400 m^2 of deployed area (50-100 kW) in 3-5 years.
- 400-1200 m^2 of deployed area (100-300 kW) in 5-10 years.
- 1200-4000 m^2 of deployed area (300-1000 kW) in 10-20 years.

These deployed areas are typically divided between two solar array wings, with each wing requiring half of the specified area.

This subtopic seeks innovations in the following areas for future large solar array structures:

- Novel design, packaging, deployment, and in-space manufacturing and assembly concepts.
- Lightweight, compact components including booms, ribs, substrates, and mechanisms.
- Validated modeling, analysis, and simulation techniques.
- Ground and in-space test methods.
- Load alleviation, damping, and stiffening techniques.
- High-fidelity, functioning laboratory models.

Nominal solar array requirements for large-scale SEP applications are:

- Mass specific power > 120 W/kg at beginning of life (BOL).
- Stowed volume specific power > 40 kW/m^3 BOL.
- Deployment reliability > 0.999.

- Deployed stiffness > 0.1 Hz.
- Deployed strength > 0.2 g (all directions).
- Lifetime > 5 years.

Variations of NASA's in-house large solar array concept referred to as the Government Reference Array (GRA) could be used for design, analysis, and hardware studies. Improved packaging, joints, deployment methods, etc. to enable GRA-type solar arrays up to 4000 m^2 in size (1 MW) with up to 250 W/kg and 60 kW/m3 BOL are of special interest. The GRA is described in Reference 2.

In Phase I, contractors should prove the feasibility of proposed innovations using suitable analyses and tests. In Phase II, significant hardware or software capabilities should be developed and demonstrated to advance their Technology Readiness Level (TRL). TRLs at the end of Phase II of 3-4 or higher are desired.

References:

- "Concept Design of High Power Solar Electric Propulsion Vehicles for Human Exploration"

(http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20120000068_2011025608.pdf).

- Pappa, R. S. et al., "Solar Array Structures for 300 kW-Class Spacecraft," Presented at the Space Power Workshop, April 24, 2013.