NASA SBIR 2004 Phase I Solicitation

S2.02 Terrestrial and Extra-Terrestrial Balloons and Aerobots

Lead Center: GSFC

Participating Center(s): JPL

Innovations in materials, structures, and systems concepts have enabled buoyant vehicles to play an expanding role in NASA’s Space and Earth Science Enterprises. A new generation of large, stratospheric balloons based on advanced balloon envelope technologies will be able to deliver payloads of several thousand kilograms to above 99.9% of the Earth’s absorbing atmosphere and maintain them there for months of continuous observation. Smaller scale, but similarly designed, balloons and airships will also carry scientific payloads on Mars, Venus, Titan, and the outer planets in order to investigate their atmospheres in situ and their surfaces from close proximity. Their envelopes will be subject to extreme environments and must support missions with a range of durations. Robotic balloons, known as aerobots, have a wide range of potential applications both on Earth and on other solar system bodies. NASA is seeking innovative and cost-effective solutions in support of terrestrial and extraterrestrial balloons and aerobots in the following areas.

Stratospheric Long Duration Balloon (LDB) Support

Materials

- Innovative membranes for terrestrial applications to support the Long Duration Balloon (LDB) and Ultra-Long Duration Balloon (ULDB) development efforts. The material of interest shall meet all environmental, design, fabrication, and operational requirements and must be producible in large quantities in a lay-flat width of at least 1.6 m.

- Innovative concepts for reducing the UV degradation of flight components including balloon membranes, load carrying members, and parachute components.

Support Systems

- Innovative concepts for trajectory control and/or station-keeping for effectively maneuvering large
terrestrial and small extraterrestrial aerobots in either the horizontal latitude or vertical altitude plane or both.

- Innovative low mass, high density, and high efficiency power systems for terrestrial balloons that produce 2 kW or more continuously.
- Innovative power systems that enable long duration, sunlight independent missions for a duration of 30 days or more.
- Innovative, low cost, low power, low mass, precision instrument pointing systems that permit arcsecond or better accuracy.
- Innovative sensor concepts for balloon gas or skin temperature measurements.
- Innovative floatation systems for water recovery of payloads.

**Design and Fabrication**

- Innovative, efficient, reliable and cost-effective balloon fabrication and inspection techniques to support the current ULDB development efforts.
- Innovative balloon design concepts for long duration missions which can provide any or all of the following:
  - Reduced material strength requirements;
  - Increased reliability;
  - Enhanced performance;
  - Reduced manufacturing time;
  - Reduced manufacturing cost; and
  - Improved mission flexibility.

**Titan Missions Support**

Titan is the second largest moon in the solar system and the only one that features a sufficiently dense atmosphere for buoyant vehicle flight. Targeted for exploration by Cassini-Huygens in 2004 and beyond, Titan is expected to be a geologically and chemically diverse world containing important clues on the nature of prebiotic chemistry. NASA is starting to lay the ground work for post-Cassini-Huygens exploration of Titan using highly autonomous, self-propelled aerobots capable of surveying many widely separated locations on the world and potentially including surface sampling and composition analysis. Innovative technologies are sought in the following areas:

- Concepts, devices and materials for sealing (repairing) of small holes in the balloon envelope material during flight at Titan. Repair of these holes may be required to enable the long mission lifetimes (6–12 months) desired at Titan. Although the balloon envelope material for Titan has not yet been specified, repair strategies should be generally compatible with polymer materials and the 90 K environment. It is imperative that proposed solutions be low mass (on the order of a few kilograms) and low power (a few Watts).
- Concepts and devices for the processing of atmospheric methane into hydrogen gas and its use as a
makeup gas to compensate for leakage during operational flight at Titan. It is imperative that proposed solutions be low mass (on the order of a few kilograms) and low power (a few Watts).

**Venus Missions Support**

Venus is the second planet from the Sun and features a dense, CO$_2$ atmosphere completely covered by clouds. Although already explored by various orbiters and short-lived atmospheric probes and landers, Venus retains many secrets pertaining to its formation and evolution. One of NASA’s long-term objectives is to develop the technologies required for a surface sample return mission. A high temperature balloon is one key element that will be needed to loft the sample from the surface to a high altitude for launching a return rocket back to Earth. Innovative technologies are, therefore, sought in the following area:

- Designs, materials, and prototypes for surface-launched Venus balloons. Balloon volumes in the range of 0.5–5 m$^3$ are required when fully inflated. The balloon must be storable in a packaged condition for up to 1 year and have an areal density of less than 1000 g/m$^2$. Proposed concepts must include an automatic surface launch that will work in the Venus environment consisting of 460°C temperature, 90 atmosphere pressure, and surface winds of up to 1 m/s.