NASA SBIR 2006 Phase I Solicitation

S2.02 In Situ Planetary Atmospheric Measurement Technologies

Lead Center: JPL

Participating Center(s): ARC, GRC, GSFC, MSFC

Proposals are sought for technologies that enable the in situ exploration of the surface and deep atmosphere of Venus and the deep atmospheres of Jupiter or Saturn for future NASA missions. Venus features a dense, CO$_2$ atmosphere completely covered by clouds with sulfuric acid aerosols, a surface temperature of 486°C, and a surface pressure of 90 atmospheres. Although already explored by various orbiters and short-lived atmospheric probes and landers, Venus retains many secrets pertaining to its formation and evolution. NASA is interested in expanding its ability to explore the deep atmosphere and surface of Venus through the use of long-lived (days or weeks) balloons and landers. Survivability in extreme high temperatures (~480°C) and high pressures (~100 atmospheres) is also required for deep atmospheric probes to giant planets. Technology advancements to permit operation and survivability in high-temperature/high-pressure planetary environments are sought in the following areas:

Pressure Vessels and Structural Shells

Historically, titanium and aluminum have been used as structural shells or pressure vessels for extreme environment planetary probes and landers. Improvements in the state-of-the-art of pressure vessel materials are sought to reduce the mass of such components by 20 to 50% over titanium shells. New structural shell materials shall exhibit high strength and stiffness at elevated temperatures and shall be resistant to creep and buckling under high external pressures.

Thermal Control Systems

Survivability of electronic components in high temperature environments relies on three basic areas of thermal control: isolation, thermal capacitance and/or refrigeration. Specific improvements in are sought in the development of:

- Lightweight and stable insulation materials with a conductivity less than 0.1 W/m-K at 486°C and 90 atm pressure;
- Thermal energy storage systems with 300 - 1000 kJ/kg energy density through either phase changes or chemical heat absorption;
- High performance, low mass refrigeration cooling systems capable of pumping on the order of 100 Watts of
heat from a 100ºC source to the Venus sink temperature of 486ºC. In this area, particular attention must be paid to the power source for such a system. A total systems approach must be considered as opposed to development of a particular component.

High Temperature Electronics

- Science and engineering sensors able to operate at 486ºC and 100 bar, including for example, high temperature imagers, hybrid imaging system that utilizes high temperature fiber optics, seismometers, and pressure sensors;

- High-temperature, low-power, and ultra low-power electronics and electronic packaging technology for sensor and actuator interfaces at 486ºC, including low-noise (10 nV/sqHz) preamplifiers, power amplifiers and transmitters (S-band), temperature stable oscillators, drivers (with 0-100 V digital output for driving piezoelectric, electrostatic, or electromagnetic actuators), and high value (on the order of one to hundreds of micro Farad) capacitors;

- Computer aided simulation tools for predicting the performance, reliability, and life cycle for high-temperature electronic systems and components.

High Temperature Motors and Actuators

- Actuators for sample handling and acquisition systems including high-temperature drills, motors, and actuators able to operate in the 486ºC, 90 atmosphere surface environment of Venus.