NASA SBIR 2009 Phase I Solicitation

S3.02 Thermal Control Systems

Lead Center: GSFC

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

Future Spacecraft and instruments for NASA's Science Mission Directorate will require increasingly sophisticated thermal control technology. Some of these requirements include:

1. Optical systems, lasers and detectors require tight temperature control, often to better than +/- 1Â°C. Some new missions such as LISA require thermal gradients held to even tighter micro-degree levels.
2. Exploration science missions beyond earth orbit present engineering challenges requiring systems which are more self-sufficient and reliable.
3. The introduction of low-cost, small, rapidly configured spacecraft requires the development of new thermal technologies to reduce the time and costs typically required for analysis, design, integration, and testing of the spacecraft.

Innovative proposals for the cross-cutting thermal control discipline are sought in the following areas:

- Methods of precise temperature measurement and control to tight temperature levels.
- High conductivity, vacuum-compatible interface materials to minimize losses across make/break interfaces.
- High conductivity materials to minimize temperature gradients and provide high efficiency light-weight radiators, including interfaces to heat pipes and fluid loops that overcomes issues with CTE mismatch.
- Advanced more efficient thermoelectric coolers capable of providing cooling at ambient and cryogenic temperatures,
- Advanced thermal control coatings, particularly those with low absorptance, high emmittance, and good electrical conductivity. Also, variable emittance surfaces to modulate heat rejection are needed.

- Single and two-phase mechanically pumped fluid loop systems which accommodate multiple heat sources and sinks, and long life, lightweight pumps for these systems. Also includes advanced fluid system components such as accumulators, valves, pumps, flow rate sensors, etc. optimized for improved reliability, long life, and low resource needs.

- Phase change systems for Mars or Lunar applications. Reusable phase change systems are desired which can be employed to absorb transient heat dissipations during instrument operations. Technology is sought for phase change systems which can then either store this energy or provide an exothermic process which would provide heat for instrument power-on after the dormant phase.

- Ionic liquids, salts composed of separate cations and anions, have been known but not intensely studied. Because of their tunable and thus extremely favorable solvent and materials properties, ionic liquids are potentially useful for a wide range of space applications, e.g. liquid-mirror telescopes and heat transfer of fluids that could enhance lunar regolith geothermal potential many-fold.

- Efficient, lightweight, oil-less, high lift vapor compression systems or novel new technologies for high performance cooling up to 2 KW.

- Advanced thermal modeling techniques that can be easily integrated into existing codes, emphasizing inclusion of two-phase systems and mechanically pumped system models.

- Integration of standardized formats into existing analytical codes for the representation and exchange of thermal network models and thermal geometric models and results.

- Analytical codes to automate the generation of reduced thermal models from larger models, including routines to verify the accuracy of the reduced models.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware and software demonstration. Phase 2 should deliver a demonstration unit or software package for NASA testing at the completion of the Phase 2 contract.

Proposals should show an understanding of one or more relevant science needs, and present a feasible plan to fully develop a technology and infuse it into a NASA program.