PHASE II PROJECT SUMMARY

Firm: Physical Sciences Inc.
Contract Number: NNJ08JD44C
Project Title: Multi-Use Solar Thermal System for Oxygen Production from Lunar Regolith

This report discusses the results of the SBIR Phase II program titled "Multi-use Solar Thermal System for Oxygen Production from Lunar Regolith". In this solar thermal system, solar radiation is collected by the concentrator array which transfers the concentrated solar radiation to the optical waveguide (OW) transmission line made of low loss optical fibers. The OW transmission line directs the solar radiation to the thermal receiver for thermochemical processing of lunar regolith for oxygen production on the lunar surface.

The preceding Phase I program showed that the optical waveguide (OW) solar thermal system is a viable and efficient thermal power source for oxygen production from lunar regolith. The objectives of this follow-on Phase II program are:

1. Develop an engineering prototype of the optical waveguide (OW) solar thermal system;
2. Integrate the solar thermal system with the carbothermal reduction reactor for utility demonstration and performance evaluation;
3. Improve the key components to the level acceptable for a space-based operational system; and
4. Develop an alternative power system for additional 1 kW thermal power to the carbothermal reactor.

In this Phase II program Physical Sciences Inc. (PSI) designed, fabricated, integrated and tested the engineering prototype of the optical waveguide (OW) solar thermal system. In January 2010, after a series of tests, the solar thermal system, along with the carbothermal reactor developed by ORBITEC Corporation, was transported to the ISRU analog test site at Mauna Kea, HI. During the ISRU analog test, the solar thermal system was operated in adverse field conditions. In spite of the adverse conditions, the PSI solar thermal system completed all of its tasks.

In view of the operational successes achieved in the ISRU analog test, PSI concluded that the performance objectives of the engineering prototype OW solar thermal system were successfully accomplished. PSI has developed a plan to improve the engineering prototype system to a space qualified system. This improvement will be at the component-by-component level without requiring unrealistic breakthroughs.

PSI developed the Direct Diode Laser (DDL) thermal power system to supplement the PSI solar concentrator system. The DDL thermal power system consists of two 500 W units and integration optics which connects the DDL power source with the carbothermal reactor. The DDL power sources and the integration optics were delivered to ORBITEC Corporation at the direction of NASA/JSC in May 2010 where the system has been used for carbothermal oxygen production experiments.