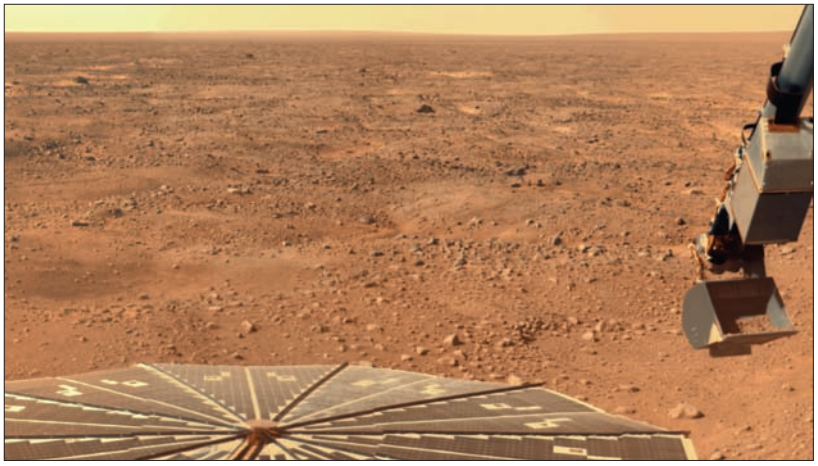
Aerospace power

High-efficiency photovoltaics continued their upward performance march using the inverted metamorphic (IMM) crystalline solar cell first patented by the National Renewable Energy Laboratory (NREL). IMM development, undertaken by Emcore and Spectrolab under contract with Air Force Research Laboratory (AFRL), has resulted in a world record efficiency of 32.7% in space sunlight. NREL, together with Emcore and AFRL, received the coveted 2008 R&D 100 Award for the space IMM solar cell, deemed one of the most innovative technology developments of the year.

United Solar Ovonic, under contract with AFRL, has successfully scaled up its roll-to-roll manufacturing process for high specific power amorphous silicon solar cells. These devices have seen successful application on the QinetiQ high-altitude, long-endurance aircraft and are slated to provide primary power for AFRL's experimental plug-n-play satellite as part of the MicroSat Systems FITS (folded, integrated, thin-film, stiffened) solar array.



ATK's Mars Phoenix UltraFlex solar array was successfully deployed on the planet.

The Mars Phoenix UltraFlex solar arrays built by ATK were successfully deployed on the red planet, with nominal power performance on both 2.1-m-diam, 118-W/kg wings. ATK and Emcore have also successfully integrated 10-μm-thick IMM solar cells onto an advanced UltraFlex gore, with a projected specific power of 400 W/kg at the solar array system level.

The stretched lens array (SLA) photovoltaic concentrator is being integrated as an experiment on the TacSat IV spacecraft built by the Naval Research Laboratory. Its concentrating Fresnel lens, which focuses sunlight at 8X concentration onto Emcore triple-junction cells, incorporates a proprietary thick coating applied by Ion Beam Optics, and a thick but low-mass coverglass on the miniaturized solar cell. The spacecraft will be placed in a high-radiation orbit, providing valuable information to validate the SLA's durability.

Boeing and Hamilton Sundstrand have received contracts to design an advanced solar concentrating photovoltaic power system for an electrically propelled spacecraft. Phase 1 of DARPA's Fast Access Spacecraft Testbed (FAST) program is performing preliminary design of the high power generation subsystem, with a goal of 130 W/kg specific power for the complete solar array wing, including deployment, pointing and tracking, and power management, over 10 times that of conventional systems.

The advanced Stirling radioisotope generator (ASRG) being developed by NASA/DOE is aiming to reduce Pu-238 requirements through a fourfold increase in efficiency while doubling the specific power. A team from Sunpower and GRC is suppying the advanced Stirling converters that exceed 38% efficiency. Lockheed Martin is integrating the converters into the engineering unit generator that includes its advanced controller. The converters' high efficiency and small size enable the ASRG to surpass a specific power of 7.0 W/kg. The generator has successfully completed performance testing in air and in vacuum, including EMI (electromagnetic interference) and vibration tests.

NASA/DOE also is continuing development of fission surface power system (FSPS) technology for lunar surface power. The reference FSPS concept, based on a 900-K liquid metal cooled reactor coupled to Stirling or backup Brayton option power converters, produces about 40 kW. NASA Glenn and NASA Marshall are partnering on tests that combine non-nuclear reactor heat simulators with subscale power conversion units. NASA Glenn completed testing of a 25-kW closed Brayton cycle power conversion system and a 2-kW dual-opposed Stirling power conversion system.

Boeing's new 787 Dreamliner has advanced the state of the art of aircraft power. Developed as a more-electric airplane, it distributes over five times the power of comparable aircraft. To reduce fuel consumption, it uses electricity instead of traditional pneumatic systems. Bleed air from the engines has essentially been eliminated—for example, the cabin is pressurized by electric motors, and antiicing of the wings is accomplished via electric heaters. A pair of large generators on each engine extract more than four times the traditional amount of electrical power and also serve as motors for engine start.

by **Ted Stern**
and the **AIAA Aerospace Power Systems Technical Committee**