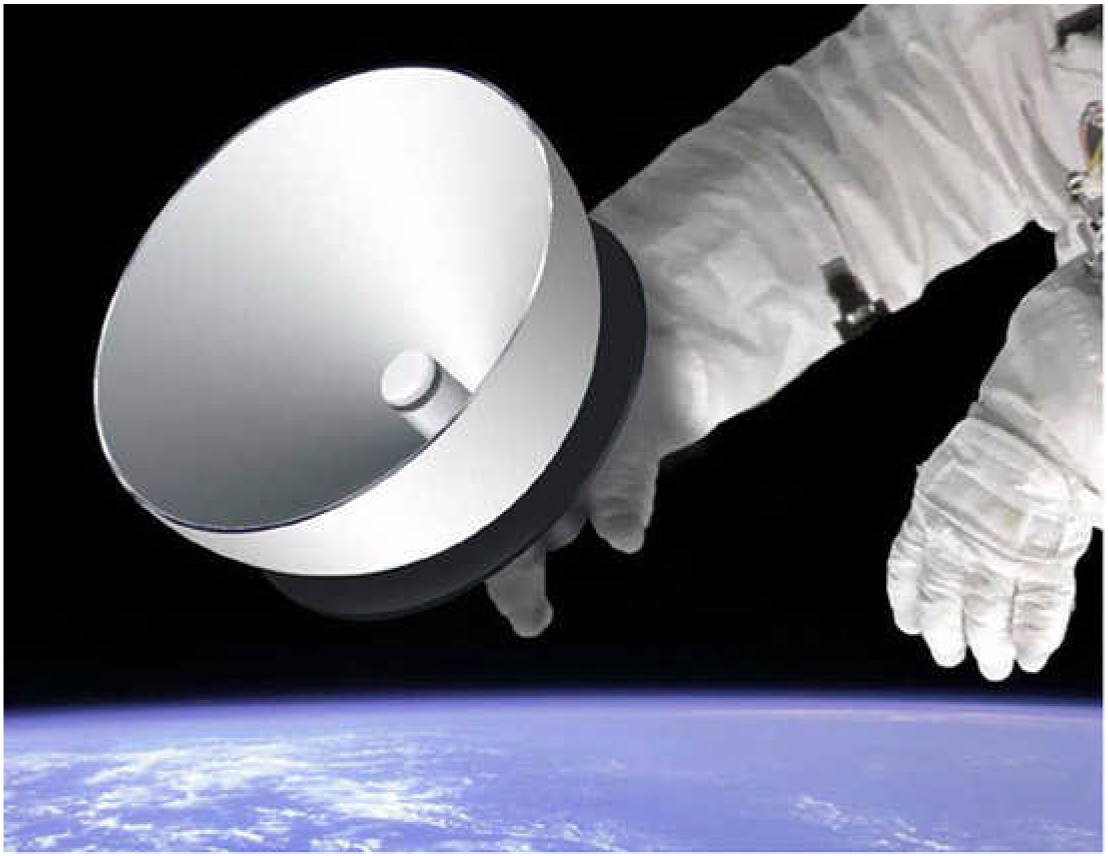
Solar Selective Coatings Prepared From Thin-Film Molecular Mixtures and Evaluated

Thin films composed of molecular mixtures of metal and dielectric are being considered for use as solar selective coatings for a variety of space power applications. By controlling molecular mixing during ion-beam sputter deposition, researchers can tailor the solar selective coatings to have the combined properties of high solar absorptance and low infrared emittance. On orbit, these combined properties simultaneously maximize the amount of solar energy captured by the coating and minimize the amount of thermal energy radiated. The solar selective coatings are envisioned for use on minisatellites, for applications where solar energy is used to power heat engines or to heat remote regions in the interior of the spacecraft. Such systems may be useful for various missions, particularly those to middle Earth orbit.

Sunlight must be concentrated by a factor of 100 or more to achieve the desired heat inlet operating temperature. At lower concentration factors, the temperature of the heat inlet surface of the heat engine is too low for efficient operation, and at high concentration factors, cavity type heat receivers become attractive. The illustration shows an artist’s concept of a heat engine, with the annular heat absorbing surface near the focus of the concentrator coated with a solar selective coating. In this artist’s concept, the heat-absorbing surface powers a small Stirling convertor. The astronaut’s gloved hand is provided for scale.



Artist's concept of a Stirling convertor employing a solar selective coating.

Several thin-film molecular mixtures have been prepared and evaluated to date, including mixtures of aluminum and aluminum oxide, nickel and aluminum oxide, titanium and aluminum oxide, and platinum and aluminum oxide. For example, a 2400-Å-thick mixture of titanium and aluminum oxide was found to have a solar absorptance of 0.93 and an infrared emittance of 0.06. On the basis of tests performed under flowing nitrogen at temperatures as high as 680 °C, the coating appeared to be durable at elevated temperatures. Additional durability testing is planned, including exposure to atomic oxygen, vacuum ultraviolet radiation, and high-energy electrons.

Find out more about the research of Glenn's Electro-Physics Branch http://www.grc.nasa.gov/WWW/epbranch/ephome.htm.

Glenn contact: Dr. Don Jaworske, 216-433-2312, Donald.A.Jaworske@nasa.gov
Author: Dr. Don A. Jaworske
Headquarters program office: OAT
Programs/Projects: DDF, Power System Surfaces/Materials Technology