the speed and uniformity of ohmic heating, which minimizes exposure of sensitive materials to high temperatures. In principle, the material may be heated rapidly to sterilization conditions, cooled rapidly, and stored.

The ohmic heating device herein is incorporated within a package. While this by itself is not novel, a reusable feature also was developed with the intent that waste may be stored and re-sterilized within the packages. These would then serve a useful function after their use in food processing and storage.

The enclosure should be designed to minimize mass (and for NASA's purposes, Equivalent System Mass, or ESM), while enabling the sterilization function. It should also be electrically insulating. For this reason, Ultem® high-strength, machinable electrical insulator was used.

Because the pouch would expand when exposed to heating to sterilization temperatures (greater than 121 °C), it is necessary to prevent seal rupture by applying air pressure into the enclosure. To enable cooling of the package in the enclosure, a water inlet and outlet are provided. The electrode tabs could be modified to form a larger pair of electrodes, which will also allow heating of water within the enclosure if necessary.

Under normal reheating conditions, temperatures will not need to go above 100 °C, thus the air overpressure feature will be unnecessary. The plan is to provide a user interface with a keypad that will enable users to dial in the heating protocol depending on the product that is within the chamber. This feature could be automated.

The incidence of electrolysis will be minimized using a solid-state IGBT power supply at 10 kHz. This is critical in a space application, since bubble formation at the electrodes can stop the heating unless electrolysis can be suppressed.

This work was done by Sudhir K. Sastry, Brian F. Heskitt, Soojin Jun, Joseph E. Marcy, and Ritesh Mahna of Ohio State University for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-23999-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Radio Frequency Plasma Discharge Lamps for Use as Stable Calibration Light Sources

Electrode-induced instabilities are eliminated and the lifetime is not limited by electrode erosion.

Goddard Space Flight Center, Greenbelt, Maryland

Stable high radiance in visible and near-ultraviolet wavelengths is desirable for radiometric calibration sources. In this work, newly available electrodeless radio-frequency (RF) driven plasma light sources were combined with research-grade, low-noise power supplies and coupled to an integrating sphere to produce a uniform radiance source. The stock light sources consist of a 28 VDC power supply, RF driver, and a resonant RF cavity. The RF cavity includes a small bulb with a fill gas that is ionized by the electric field and emits light. This assembly is known as the emitter. The RF driver supplies a source of RF energy to the emitter.

In commercial form, embedded electronics within the RF driver perform a continual optimization routine to maximize energy transfer to the emitter. This optimization routine continually varies the light output sinusoidally by approximately 2% over a several-second period. Modifying to eliminate this optimization eliminates the sinusoidal variation but allows the output to slowly drift over time. This drift can be minimized by allowing sufficient warm-up time to achieve thermal equilibrium. It was also found that supplying the RF driver with a low-noise source of DC electrical power improves the stability of the lamp output. Finally, coupling the light into an integrating sphere reduces the effect of spatial fluctuations, and decreases noise at the output port of the sphere.

The RF-driven lamps have several advantages over traditional calibration sources. Currently, accurate radiance measurements can be made at infrared and the red portion of the visible wavelengths using tungsten filament-style FEL lamps. However, the blackbody output of these lamps is limited to 3,000 K, and intensity falls exponentially at shorter wavelengths at the blue end of the spectrum. For reproduction of the solar spectrum, with an equivalent blackbody temperature of 6000 K, the blue and ultraviolet wavelengths have typically been produced using high-pressure xenon arc discharge lamps. These lamps achieve the high temperature necessary in a narrow filament of ionized gas between two electrodes. This ion channel suffers from instabilities produced by buoyancy-induced turbulence of the surrounding gas. There is also longer-term drift associated with the sputtering of electrode material through ion impact, which changes both the electrode spacing and surface profile. Due to the high electric field gradients, these small changes in geometry result in non-negligible changes to the light output.

Additionally, much of the sputtered electrode material is deposited as a thin layer on the inner surface of the lamp. This decreases light transmission through the glass and ultimately limits the useful life of the lamp to no more than 1,000 hours, over the course of which the radiant flux may decrease by a factor of two. Additionally, the xenon lamps generate several undesirable sharp emission lines with large intensity variation over a small spectral range. The electrode-induced instabilities are eliminated in the RF lamp, and the lifetime is not limited by electrode erosion. The higher operating pressure of the RF-driven bulbs produces a smoother broadband spectrum. The RF lamps are also more efficient, and have more conducive geometry for coupling their light into an integrating sphere.

This work was done by Brendan McAndrew and John Cooper of Goddard Space Flight Center; and Angelo Arecchi, Greg McKee, and Christopher Durell of Labsphere, Inc. Further information is contained in a TSP (see page 1). GSC-16399-1