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NASA TECH BRIEF

Foil Radiometer Accessory Improves Measurements

The problem:

To increase the responsiveness and to simultaneously decrease the time constant of a foil radiometer used to measure radiation from a high-energy environment. These two characteristic changes cannot usually be made simultaneously. For example, a decreased time constant could be accomplished by reducing the foil area, but this would decrease the responsiveness of the instrument.

The solution:

Isolate the foil in a controlled environment, and by means of an optical system, couple it to the media to be measured. The optical system focuses the radiant flux on a very small area at the center of a tantalum foil—the area which carries the thermocouple junction. This concentration of energy at the junction permits the junction temperature to respond more quickly than if the energy is distributed over the entire area of the foil.

How it's done:

The radiometer, comprised of an optical system and thin foil thermocouple detector, is enclosed in a sealed metal housing covered with thermal insulation. The housing is purged at a low flowrate with nitrogen gas which is exhausted around a sapphire window that serves as the entry aperture for the radiant flux.

In operation, the optical system establishes the field of view and focuses the radiant flux at the center of the foil. This results in a higher differential temperature between the center of the foil and foil support surface around its face, and upgrades the sensitivity of the instrument. Because the incoming radiant energy is concentrated at one small area, the area heats more rapidly and results in a decreased time constant for the instrument.

The controlled field of view of the optical system permits a high degree of selection in the portion of the source that is being observed, and provides critical measurement capability. Optical systems of prototype models provide a field of view of 6.16°.

Notes:

1. In test, output signal stability was within 0.3 percent over a 10-minute interval when exposed to a blackbody source radiating at a level of 250 watts/cm^2. When subjected to step changes of 50 watts/cm^2 in the radiation level, the signal consistently reached 63.2 percent of its final value in less than 200 milliseconds. Control of the spectral range being measured was accomplished by conventional filtering.
2. A further in-depth study has been made to determine how to increase the signal output (in millivolts) of a thermal foil radiometer for a fixed-exposure time interval within severe dimensional restraints. Consideration has been given to configuration geometry, thermal characteristics, and thermoelectric properties of available materials, Results indicate that an increase of >60 percent signal output is potentially available.

   The radiometer is fabricated from 0.0002-inch constantan foil, a relatively massive copper support that functions as a heat sink, and 0.001-inch copper wire. The instrument delivers a signal that is nearly linear with irradiance. The preferred foil geometry is a strip having a center-to-end width ratio of 4 to 1. This represents a 30 percent improvement over a rectangular strip, which has been found to be 62 percent better than a circular foil with full peripheral support as used in conventional radiometers.

(continued overleaf)

3. Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
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Patent status:

No patent action is contemplated by NASA.

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