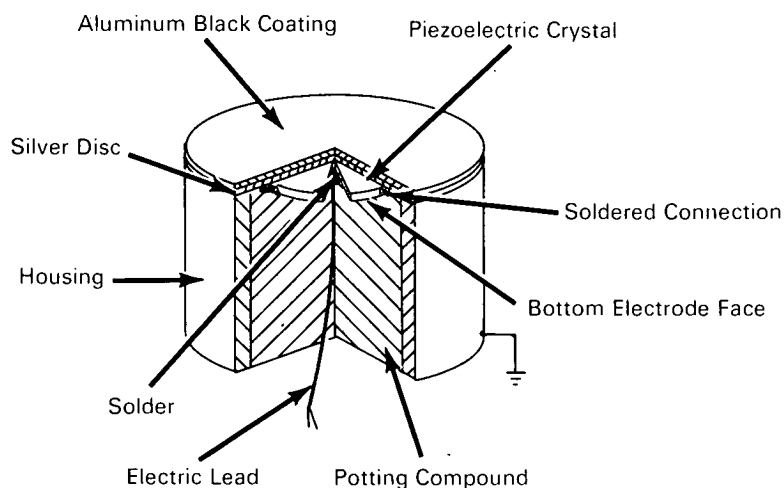


NASA TECH BRIEF



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Gage Measures Total Radiation, Including Vacuum UV, from Ionized High-Temperature Gases



A transient-heat transfer gage has been developed to measure the total radiation intensity from vacuum ultraviolet (below 1200 angstroms) and ionized high-temperature gases. Available metal thin-film or pyroelectric gages cannot be used for such measurements. The surface of the thin-film gage is shorted, and the surface electrodes of the pyroelectric gage are penetrated by vacuum ultraviolet photons, causing noise and depolarization of the sensor crystal.

The new transient-heat transfer gage is of rugged construction and includes a sensitive piezoelectric crystal that is completely isolated from any ionized flow and vacuum ultraviolet irradiation. The main advantage of the gage is its ability to provide total heat transfer data without the use of a quartz window, which would eliminate from measurement radiation

below 1200 angstroms. The gage has a microsecond response time and can be repeatedly used without substantial change in its calibration constant. It is much simpler to construct, as it incorporates a thermally thick metal disc rather than molecular-thickness metal films which are difficult to deposit. The gage operates by sensing thermally induced mechanical stress waves which travel through the disc 500 times faster than thermal waves.

As shown in the figure, the gage includes a thermally thick silver disc having a radiant energy-receiving aluminum black coating on its exterior surface and a strain-sensing piezoelectric crystal bonded to its inner surface by a soldered connection. The bottom electrode face of the crystal is soldered to an electric lead. The upper electrode face of

(continued overleaf)

the crystal is connected through the silver disc and the gage housing to ground. The electrodes are electrically insulated and the structure is given mechanical rigidity by a potting compound, which also bonds the gage elements together.

Surface heating due to radiation absorbed on the aluminum black coating produces a thermally induced strain on the silver disc. This strain, a radial expansion of the silver disc, is proportional to the heat flux and is transmitted rapidly to the piezoelectric crystal. The polarization vector of the crystal is normal to the strain direction, resulting in an electrical charge proportional to the heat flux being developed between the crystal electrode faces. The electrical output from the gage is delivered to a voltage recorder or display device such as an oscilloscope.

Unwanted pressure and vibration response from plasma can be eliminated by housing the gage in a cavity during measurement. Gages in such housings were used to measure the total radiant intensity of air plasma at 10,000° to 15,000°K in the reflected shock region of a 12-inch-diameter, arc-driven shock tube. A gage was supported in a cavity viewing the radiation through a small windowless aperture located flush with the inside wall of the shock tube. The gages

performed satisfactorily until the inflow struck the gage surfaces and obliterated the radiative signal by a higher rate of convective heating. The gages were not harmed by this adverse environment. They were used for more than 60 shots without any substantial change in their calibration constants.

Notes:

1. Additional details are given in a disclosure available from the
Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: B69-10028
2. The results of experimental measurements with the gage on the total radiant intensity from a plane slab of stagnant hot test gas created in the reflected shock region of a 12-inch-diameter, arc-driven shock tube are discussed in AIAA Paper No. 67-311, "Measurements of the Total Radiant Intensity of Air," by A. D. Wood, H. Hoshizaki, J. C. Andrews, and K. H. Wilson, April 17-20, 1967. Copies of the paper are available from American Institute of Aeronautics and Astronautics. (Price AIAA member \$0.75, nonmember \$1.50.)

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, non-exclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C., 20546.

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of Lockheed Missiles and Space Co.
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