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NASA TECH BRIEF

Ames Research Center

Increasing the Response of PIN Photodiodes to the Ultraviolet

The problem:

Photomultipliers are not ideal for spacecraft experiments designed to measure solar radiation because they are heavy and bulky and because they require high voltage for operation. Moreover, their sensitivities do not remain constant, and those which may be useful for measuring ultraviolet radiation show little response above 600 nanometers. On the other hand, silicon detectors such as PIN photodiodes are miniature low-voltage devices which have adequate response in the near infrared, but they are of sharply limited applicability for measuring ultraviolet radiation in the region of 200 to 400 nanometers because of low quantum efficiency or high noise equivalent power. In view of the advantages offered by solid state devices, improvement of the ultraviolet response of commercially available diffused PIN diodes was considered an urgent problem.

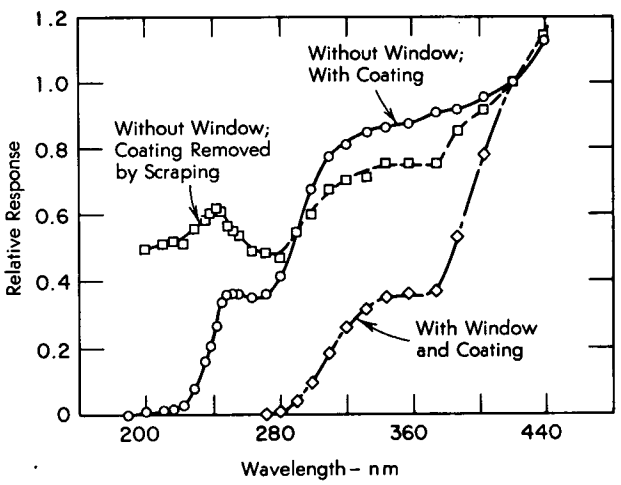
The solution:

Use of sapphire windows and avoidance of coatings which absorb ultraviolet radiation and ultimately alter detector geometry.

How it's done:

The glass protective window is removed from the housing of a commercial photodiode, and if the front surface of the diode is coated with a polymer or elastomer, this material is carefully scraped away. However, it is best to use photodiodes which have never been coated or packaged.

The increased response of a typical commercial PIN photodiode is illustrated by the curves in the diagram. Measurement of the responsivity profile of PIN photodiodes with a photometric microscope shows that the peripheral area outside the normal active area contributes to the overall response, especially at higher bias voltages. Moreover, the peripheral area is the major contributor to ultraviolet



response; thus, for sensitivity in this spectral region, the area adjacent to the normal active area must be illuminated. The peripheral response results from the fact that in this area the photons pass directly into an intrinsic, well-depleted area and the photo-induced electron-hole pairs are immediately separated and drawn out. (In the active p-region, the absorption is so strong that UV photons are absorbed before they reach the depletion region.)

The ultimate solution for ultraviolet response is a geometry with maximum peripheral area and horizontal field structure to draw out the photon-induced current carriers.

(continued overleaf)

Reference:

Whiting, E. E.; Burrous, C. N.; and Sorensen, H.: Improved Ultraviolet Response of a PIN Photodiode. Applied Optics, vol. 7, page 2141, October 1968.

Notes:

1. The stability of the response of windowless, scraped photodiodes was found to be quite constant over several weeks.
2. Recent Schottky barrier photodiodes have good ultraviolet response because the gold top surface is thin (15 nm).
3. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B72-10053

Patent status:

No patent action is contemplated by NASA.

Source: C. N. Burrous and
E. E. Whiting
Ames Research Center

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