Photocatalytic Active Radiation Measurements and Use

This technology can be used to improve the ability to predict the performance of photocatalytic materials under different illumination conditions.

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Photocatalytic materials are being used to purify air, to kill microbes, and to keep surfaces clean. A wide variety of materials are being developed, many of which have different abilities to absorb various wavelengths of light. Material variability, combined with both spectral illumination intensity and spectral distribution variability, will produce a wide range of performance results. The proposed technology estimates photocatalytic active radiation (PcAR), a unit of radiation that normalizes the amount of light based on its spectral distribution and on the ability of the material to absorb that radiation.

Photocatalytic reactions depend upon the number of electron-hole pairs generated at the photocatalytic surface. The number of electron-hole pairs produced depends on the number of photons per unit area per second striking the surface that can be absorbed and whose energy exceeds the bandgap of the photocatalytic material. A convenient parameter to describe the number of useful photons is the number of moles of photons striking the surface per unit area per second. The unit of micro-einsteins (or micromoles) of photons per m² per sec is commonly used for photochemical and photoelectric-like phenomena. This type of parameter is used in photochemistry, such as in the conversion of light energy for photosynthesis.

Photosynthetic response correlates with the number of photons rather than by energy because, in this photochemical process, each molecule is activated by the absorption of one photon. In photosynthesis, the number of photons absorbed in the 400-700 nm spectral range is estimated and is referred to as photosynthetic active radiation (PAR). PAR is defined in terms of the photosynthetic photon flux density measured in micro-einsteins of photons per m² per sec. PcAR is an equivalent, similarly modeled parameter that has been defined for the photocatalytic processes.

Two methods to measure the PcAR level are being proposed. In the first method, a calibrated spectrometer with a cosine receptor is used to measure the spectral irradiance. This measurement, in conjunction with the photocatalytic response as a function of wavelength, is used to estimate the PcAR. The photocatalytic response function is determined by measuring photocatalytic reactivity as a function of wavelength. In the second method, simple shaped photocatalytic response functions can be simulated with a broad-band detector with a cosine receptor appropriately filtered to represent the spectral response of the photocatalytic material. This second method can be less expensive than using a calibrated spectrometer.

This work was done by Jay Gurecki of Kennedy Space Center; Bob Scully of Johnson Space Center; and Allen Davis, Clay Kirkendall, and Frank Bucholtz of the Naval Research Laboratory. Further information is contained in a TSP (see page 1), KSC-13221.

Computer Generated Hologram System for Wavefront Measurement System Calibration

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Computer Generated Holograms (CGHs) have been used for some time to calibrate interferometers that require nulling optics. A typical scenario is the testing of aspheric surfaces with an interferometer placed near the paraxial center of curvature. Existing CGH technology suffers from a reduced capacity to calibrate middle and high spatial frequencies. The root cause of this shortcoming is as follows: the CGH is not placed at an image conjugate of the asphere due to limitations imposed by the geometry of the test and the allowable size of the CGH.