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Investigating the Photoyield of Spacecraft Materials
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Photoemission spectra were measured for conducting, semiconducting, and insulating materials used in NASA's James Webb Space Telescope and Solar Probe Mission studies to determine the contribution of photoemissions to overall spacecraft charging.

BACKGROUND: PHOTO-INDUCED SPACECRAFT CHARGING

The photoelectric effect is an important contributor to spacecraft charging. When photons of energies greater than the work function or electron affinity (threshold energy) of a material interact with embedded electrons, the photoelectric effect, or photoemission occurs.

EXPERIMENTAL METHODS

1. Validation of Instrumentation Upgrade: Before the four spacecraft materials were measured, photoemission spectra were taken on gold (Au). A work function of about 4.85 eV was determined from these data. This corresponds to the accepted value for the work function of gold (4.8-4.9 eV), verifying the validity of the upgraded measurement system.

2. Photoemission in Monochromator Intensity Range: A photodiode spectrum was taken each day and corrected for the known photocathode quantum efficiency. The resulting spectra correspond to the light intensity from the monochromator at each photon energy. A transmission threshold of ~6.75 eV is observed.

3. Purging Monochromator Box: Purging monochromator box with nitrogen (N2) gas reduces UV light absorption by H2O and O2 gas. This enhances the transmission spectrum of the monochromator.

4. Measuring Photoemission Spectra: Spectra were taken for four spacecraft materials with energies ranging from ~2 eV to 6.75 eV, the monochromator threshold. Measurements taken in ultra high vacuum (~10^-9 torr).

RESULTS

Of the four spacecraft materials studied, only the silicon alloy on Kapton E substrate produced a detectable photo-induced current.

CONCLUSIONS

Photoemission spectra correlate with conductivity and reflectivity of materials. Metals exhibit a photo-induced current beginning at ~2.5 eV compared to ~5 eV for semiconductors and ~8.5 eV for insulators.

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