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PHYSICS 4900 PROPOSAL

FEB/6/2014

CATHODOLUMINESCENCE MEASUREMENTS OF SEVERAL BISPHENOL/AMINE EPOXY SAMPLES

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Introduction:

Spacecraft glow in space because of energetic electron bombardment from the space environment. Light emission produced by energetic electron bombardment is called cathodoluminescence. With space-based observatories, this can cause detectors to pick up light that did not originate at the objects being observed. There are three distinct forms of photon emission which have been observed in this type of environment. Arcs are very short duration (<1 ms) flashes caused by rapid discharge of a charged body. Flares are intermediate duration (10 to 100 second exponential decay constant) photon emissions which begin suddenly and then have an exponential decay. Glow is a continuous emission of photons that can be observed any time energetic electrons are incident on a material. It is proposed that all three types of photoemission will be studied for bisphenol/amine epoxy. Specifically I plan on studying the dependence of absolute spectral radiance (termed “glow”) as well as the rates of arcs and flares, on incident electron energy, current density, and power density.

Literature Review:

Ferguson, *et al.* ⁽¹⁾ discusses the different sources of light contamination that exist in space-based observatories. The greatest nonhuman source of light contamination when looking at very dark regions of space is the zodiacal background. Therefore, one of the goals in selecting materials for space based observatories is that light pollution caused by cathodoluminescence, arcing, and flares must be smaller than the zodiacal background in order to achieve the greatest sensitivity. This same type of analysis has been done on other materials by the Materials Physics Group at Utah State University. Dennison *et al.* ⁽²⁾ explains the three types of photon emission which will be studied. Jensen, *et al.* ⁽³⁾ discusses these types of phenomena for SiO₂.

Methodology:

The data for this project has already been collected in the form of video files, and electrometer files. Arc, flare, and glow information has been found, but only for one sample. Further analysis of this data will be done in order to improve statistical reliability and find a better model for cathodoluminescence behavior. I will expand the Matlab™ Gray Pixel Counter software already used by the Materials Physics Group to

simultaneously select and analyze multiple regions of video frames. Specifically, this will allow me to look at more regions, and obtain data from all of the epoxy dots (about 40 of them). This will be used to determine the glow produced by individual epoxy dots and the statistical distribution of these values. I will compare these data to electrometer data previously obtained so that connections can be made between glow, arc rate, flare rate, and electron energy, current density, and electron-beam power density.

Expected Results:

Previous data analyzed for polymer samples when exposed to typical electron fluxes in the space environment (I expect to find similar results.) show these materials glow above the zodiacal background. If bisphenol/amine epoxy exhibits glow above the zodiacal background care should be taken so that this material is not used extensively in the optical path of space-based observatories. Determination of the statistical distributions of glow, arcs and flares in a large sampling of isolated samples of the same material under nearly identical exposure conditions, will provide important validation of these results and help determine stochastic variability and experimental uncertainties.

References:

- [1] Ferguson, D. C., Krezan, J. -M., Barton, D. A., Dennison, J. R. and Gregory, S., “On the Feasibility of Detecting Spacecraft Charging and Arcing by Remote Sensing,” Paper Number, AIAA-2013-2828, 5th AIAA Atmospheric and Space Environments Conference, San Diego, CA, (2013).
- [2] Dennison, J. R., Jensen, A. E., Wilson, G., Dekany, J., Bowers, C. W., and Meloy, R., “Diverse Electron-induced Optical Emissions from Space Observatory Materials at Low Temperatures” Proc. SPIE Cryogenic Optical Systems and Instruments Conf., Paper No. 8863-12, (San Diego, 2013).
- [3] Jensen, A. E., Dennison, J. R., Wilson, G., Dekany, J., Bowers, C. W., Meloy, R., Heaney, J. B., “Properties of Cathodoluminescence for Cryogenic Applications of SiO₂-based Space Observatory Optics and Coatings” Proc. SPIE Cryogenic Optical Systems and Instruments Conf., Paper No. 8863-11, (San Diego, 2013).