SEE Bulletin

NASA's Space Environments and Effects Program January 2004

Electrostatic Return of Contaminants

By: Donna Hardage
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Contaminants generated by a spacecraft can return to a spacecraft via a mechanism known as electrostatic return (ESR). ESR can occur when spacecraft generated contaminants become ionized by solar UV or solar electrons and are returned to the spacecraft due to the spacecraft potential. The return of ionized contaminant molecules to charged spacecraft surfaces is very important at all altitudes. It is especially important at geosynchronous and interplanetary environments since it may be the only mechanism by which contaminants can degrade with application to all altitudes and spacecraft geometries.

The ESR tool is a first generation computational code created for the purpose of computing the return characteristics of spacecraft generated contaminants, which return to the spacecraft via the electrostatic return mechanism. The ESR code does not compute the spacecraft charging - this task is left to pre-existing codes. The ESR code does compute the Debye sheath (if necessary), the returned contaminant mass rate, returned mass flux, returned mass ratio, return velocity, and surface sputter (where applicable). To help the user, default values have been supplied for all program inputs. However, the user is encouraged to supply the program with appropriate inputs which accurately reflect the specific spacecraft and environmental conditions being modeled.

The model has application to large solar sails, thermal control surfaces, and solar array surfaces. It has the capability to address sputtering of spacecraft surfaces by return of the ionized contaminants. Any charge can be applied to a surface with the model as input to analyzing ionized contaminant return.

This effort was performed by ROR Enterprises and Applied Science Technologies with funding from NASA's Living With a Star/Space Environment Testbed

Program. Contact information and model distribution information can be found at **http://seem.sfc.nasa.gov**.

Displacement Damage Effects in Solar Cells

By: Donna Hardage
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The United States Naval Research Laboratory (NRL), in collaboration with the Ohio Aerospace Institute (OAI) and NASA Glenn Research Center (GRC), have executed a one year program to develop an improved space solar cell radiation response analysis capability and to produce a computer modeling tool which implements the analysis. This was accomplished, in part, through analysis (mining) of solar cell flight data taken on the Microelectronics and Photonics TestBed (MPTB) experiment. This effort was funded by NASA's Living with a Star Space Environment Testbed and is responsive to the goal "to infuse the predictive capability and technology validation results in space... to government and industry users.. for spacecraft design and operations". This effort specifically addresses issues related to rapid technological change in the area of solar cells for space applications in order to enhance system pefromance, decrease risk and reduce cost for future missions.

In this effort, data of the photogenerated current from the MPTB solar array that has been telemetered to the ground from the spacecraft were analyzed. The concept of displacement damage dose (Dd) has been used, employing the methodology developed at NRL, to characterize the radiation-induced degradation to the solar array output, and the computer code Solar Array Verification and Analysis Tool (SAVANT), being developed by OAI under contract to GRC, has been used to predict the solar array output. The ultimate goal of this work was to validate the SAVANT code against the measured space data, and to develop SAVANT into a user-friendly executable program that can be widely distributed.

Contact information and model distribution information (when available) can be found at **http://seem.sfc.nasa.gov**.

Electric Propulsion Interactions Code (EPIC)

By: Jody Minor
NASA's Space Environments and Effects (SEE) Program

The Electric Propulsion Interactions Code (EPIC) is an interactive computer toolset that can be used to evaluate the various interactions of electric thruster plumes and a spacecraft. This work is being performed by Science Applications International Corporation (SAIC) under contract to NASA's SEE Program. The code is built on the Module Integrator and Rule-based Intelligent Analytic Database (MIRIAD) architecture and enables easy 3-D spacecraft geometry definition. The code has also recently been enhanced to exchange results with the NASA/Air Force Spacecraft Charging Analyzer Program (NASCAP-2K) code, increasing its usefulness.

Many of today's satellites use electric propulsion (EP) for station-keeping duties and new designs are considering EP as the main propulsion system. However, the interactions of high-energy electric plumes and the spacecraft structure and its on-board systems are still not fully understood. As new EP designs are developed and more is demanded for near-Earth and deep space applications, the detrimental effects of these interactions may affect specific components, science measurements and mission lifetimes. Understanding how electric plumes interact with spacecraft systems is one of the keys to mission success.

The main components of EPIC are the Object Toolkit (OTk), 1-D Hall Effect Thruster (HET) Algorithm, the 2-D Plume Tool and the 3-D Interactions Code. The OTk, originally developed for use in NASCAP-2K, has been generalized and may now be used not only in EPIC but is also being considered for use in other SEE Program model development. OTk is used to develop the 3-D spacecraft geometry and specify material properties. For EPIC, OTk contains a new feature ("Special Objects") to facilitate the specification of thrusters. The 1-D HET Algorithm provides exit conditions at the end of the acceleration channel. The 2-D Plume Tool is used to produce the plume from the electric thruster and the 3-D Interactions Tool incorporates the plume model and spacecraft geometry into an interactive display for the investigation of material-specific interactions, time dependence, 3-D effects, etc., all within a unified environment. Results may

be viewed from all angles. Using the SOAP (Simple Object Access Protocol) protocol, EPIC is able to communicate with NASCAP-2K and has the potential to communicate with other spacecraft charging analysis applications as well.

Version 1.0 is scheduled for release in the spring of 2004. To obtain EPIC (US citizens only) or for more information, please visit the SEE web site at **http://see.msfc.nasa.gov**.

8th Spacecraft Charging Technology Conference Recap

The SEE Program would like to thank all those who attended the 8th Spacecraft Charging Technology Conference (SCTC) in October 2003. The conference was an overwhelming success. We have received numerous compliments regarding our performance as hosts as well as towards the overall quality of the conference. We thank you for your support and the opportunity to be involved.

We have spent the last three months preparing the papers for publication on the Proceedings CD. This package has just been sent to the publications team and we hope to distribute the Proceedings to all attendees within the next few months. In addition to the technical papers, we have included the group photograph and silhouette, many pictures of the more light-hearted moments of the conference and the presentation regarding the next conference in the series.

We hope to be a part of JAXA's 9th SCTC in Tsukuba, Japan in April 4-8, 2005. As more of their conference information is released, we'll pass this information to our spacecraft charging community. More information may be obtained by contacting Dr. Tateo Goka at **goka.tateo@jaxa.jp**.

Publications:

The following LWS/SET publications are linked to the SEE Program's web site...

Characterization of Magnetospheric Spacecraft Charging Environments Using the LANL Magnetospheric Plasma Analyzer Data Set
V.A. Davis, M.J. Mandell, and M.F. Thomsen

Electrostatic Return of Contaminants
R. Rantanen, and T. Gordon

Modeling Charge Collection in Detector Arrays
J. Pickel

TID Effects of High-Z Material Spot Shields on FPGA Using MPTB Data
S.H. Crain, J.E. Mazur, J.E. and M.D. Looper

The following publications are currently in work and will be available soon...

Displacement Damage Effects in Solar Cells

Mining Damage Data from the Microelectronics and Photonics Testbed (MPTB) Space Experiment

Solar Variability and the Near-Earth Environment – Mining Enhanced Low Dose Rate Sensitivity (ELDRS) Data From the Microelectronics and Photonics Testbed (MPTB) Space Experiment

Analysis of CRRES PHBA Data for Low-Energy Deposition Events

Mining CRRES IDM Pulse Data and CRRES Environmental Data to Improve Spacecraft Charging/Discharging Models and Guidelines

NOTE: Starting with this issue, publication of the SEE Bulletin will occur only in electronic format. To be added/removed from the distribution list, please contact Gayle Brown at **gayle.brown@msfc.nasa.gov**.

Upcoming events

Surveying and Examination of Eroded Returned Surfaces (SEERS) Project Workshop
Huntsville, Alabama/March or April 2004 (announcement will soon be released)

National Space and Missile Materials Symposium
Seattle, Washington/June 21-25, 2004

IEEE Nuclear and Space Radiation Effects Conference (NSREC)
Atlanta, Georgia/July 19-23, 2004

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In the Next Issue…

Results from the Satellite Contamination and Materials Outgassing Database Survey…

SEERS Workshop Information…

Information on the SEE Program's Move to the New Exploration Systems Enterprise (Code T)… What Does This Mean?