Modeling Vacuum Arcs On Spacecraft Solar Panel Arrays

Phase I Final Report Summary

Seth A. Veitzer, PI
Tech-X Corporation
5621 Arapahoe Ave.
Boulder, CO 80303
Phone: (720) 974-1848
Fax: (303) 448-7756
email: veitzer@txcorp.com

Contract Number: NNX13CC58P
November 22, 2013

Project Summary

Spacecraft charging and subsequent vacuum arcing poses a significant threat to satellites in LEO and GEO plasma conditions. Localized arc discharges can cause a flashover plasma expansion, that can lead to further discharge of charge stored on dielectric surfaces such as solar panel arrays, which can cause catastrophic events over large areas of the panel array surfaces. While spacecraft charging has been studied for a long time, the dynamics of flashover currents and propagation of the expanding plasma have not been well-characterized, although they are key in order to understand how to mitigate damage to solar panel arrays during discharge events.

The overall objective of this work is to provide a validated modeling tool to help researchers understand and mitigate electrostatic discharges on solar arrays. By the end of the Phase II of this work, we envision providing a simulation tool that is i) validated with the latest experimental data, and ii) is easy enough to use that any researcher in this community can use it. This project will improve the understanding of arc discharges and expanding plasma effects on dielectric structures such as solar panel arrays so that NASA will better be able to protect satellites from damaging vacuum arc discharges. We will develop accurate numerical simulations that model localized arcs, plasma expansion, and dielectric charging and discharging, under both simulated LEO and GEO plasma conditions. We also plan to extend our models to include the effects of non-uniform ambient plasma densities, secondary electron emission effects, and photo-electron effects. In Phase I, we validated our numerical models against the theoretically known problem of expansion of a plasma into a vacuum, and showed the feasibility of developing detailed simulations of a new AFRL round-robin experiment to test plasma propagation speeds in the presence of a charged dielectric material in Phase II. We also demonstrated the ability to develop easy-to-use GUI interfaces so that NASA scientists will be able to use high-performance computing resources to examine the parameter space for these types of problems without having to dive deep into the code infrastructure and numerics of the simulations. We believe that the results of the Phase I justify continuation of this project to Phase II.