Improved Satellite Robustness through Application of Erosion Resistance and High Emissivity Coatings

Rajeswaran Radhakrishnan¹, Timothy D. Hall¹, Danny Liu¹, Maria Inman¹, Stephen Snyder¹, Matthew Robertson², Trace Taylor², J.R. Dennison²

¹ Faraday Technology, ² Utah State University, Logan, UT, 84322

Objectives

- To develop and deploy a robust space charge mitigation technology to protect spacecraft components from space weather by enabling:
  - High pass active electron emission properties (anticipated to be >300% over bare Al substrate)
  - Improved durability and lifetimes in low-earth (LEO) and geosynchronous (GEO) orbits.

Technical Approach

- Tunable Composite Coating for Robust Charge Mitigation:
  - Hard material - provides resistance to erosion in severe substorm conditions
  - Conductive material - provides conductivity to distribute the negative charge across the spacecraft components
  - Low work function (LWF) material - provides enhanced electron emission properties
  - Electrochemical deposition method - Scalable, low-cost, works for complex geometries, and enables tuning of the composite structure

Results - Autonomous Emission

- To date, the composite coating was tuned to demonstrate autonomous space charge mitigation with:
  - Total Electron Yield (TEY) - 25 compared to 1.5 for Bare Al substrate
  - Extending the range of electron yields between crossover energies above 1 by ~4x

Results - Ion Erosion Resistance

- Durability of the composite coating was demonstrated through exposure to ion erosion of modeled ISS plasma erosion conditions.
  - No change in Total electron yield was observed before and after ion erosion exposure.

Composite Coating on a Variety of Geometries

- Electrochemical method enables uniform deposition of composite coatings on a variety of geometries: flat coupons, curved surfaces, sharp edges, and internal and external surfaces of square tubes

Summary/Next Steps

The robust and autonomous space charge mitigating composite coating to protect spacecraft component failures from space weather:
- Achieved ~1500% increase in autonomous electron emission over the bare Al substrate
- Extended the range of electron yields above 1 by ~4x
- Survived on the exterior of International Space Station

Potential Target Integration

Scale/transition the technology onto spacecraft components
(ex., spacecraft chassis, solar cell) for commercialization

Email Contacts:
rajeswaran@faradaytechnology.com
timhall@faradaytechnology.com
mariainman@faradaytechnology.com

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