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Low-Fluence Electron Yields of Highly Insulating Materials

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Low-Fluence Electron Yields of Highly Insulating Materials

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Project supported in part by the following missions

- James Webb Space Telescope
- Solar Probe Mission
- Radiation Belt Storm Probe
- JPL Solar Sail Research
- International Space Station
- NASA SEE Database
Spacecraft Charging

Charging Causes Anomalies

Phantom Commands

Total System Failure
Insulators Yields are Hard to Measure

\[ \text{Yield} = \frac{e_{out}^-}{e_{in}^-} \]

- Yield = 1 No Charging
- Yield > 1 Positive Charging
- Yield < 1 Negative Charging
Our Relation to Charging Code

- NASCAP 2k
- SPENVIS
- MUSCAT

Materials Properties are the Weak Point!
Triggering Threshold Charging

Small changes can cause large potentials

-10 kV

10 V
Instrument

2\times 10^4 \text{ electrons}

5 \mu s

Low Energy Flood Gun

Collector

Bias Grid

Inner Grid

Sample
Representative Data

Low-Yield Conductor

Low-Yield Good Insulator
High-Yield Good Insulator

Single Pulse Causes Charging

$\sim 2 \times 10^4$ electrons

$5 \, \mu s$
Decay Curve for $\text{Al}_2\text{O}_3$

Allow charge to build up

Intrinsic (uncharged) yield is given when $Q \to 0$
The Goal?

$$\delta(eV_s) = ??$$
\[ \sigma(E_0, Q) = \delta(E_0) + \eta(E_0, Q) \]

\[ V_S = \frac{Q_0(\sigma - 1)}{C_1} - \int \frac{Q_0 N^{SE + R}}{C_2} \frac{dN(E; E_0)}{dE} \delta_0(E_0) dE \delta_0(E_0) \]

Total Yield \[ \delta(eV_s) \]

Surface Potential \[ \delta_i(E_0, Q_i) \]

Effective Yield \[ \delta(E_0, Q) = \delta(E_0) + \eta(E_0, Q) \]

Model (DDLM)
Predicted Yield Curves at Various Surface Potentials

- Measured Yield
- Analytic Prediction as $Q \to 0$
- Analytic Prediction as $V_s = 0, 2, 5, 10, 20$ V
- Notice Predicted Duel-Peak
Summary

- Pulse Flood Measurements
- Improved Modeling

New Method of Measuring Yield

- Improved Spacecraft Modeling
- Improved Mission Success Rate