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Electron Energy Dependent Charging Effects of Multilayered Dielectric Materials

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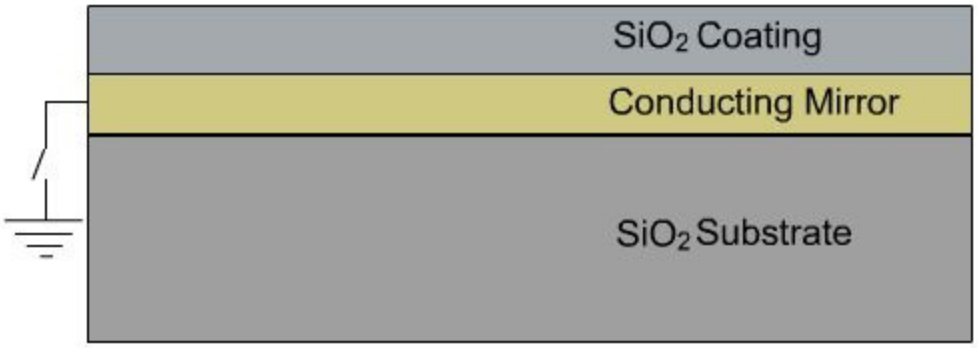
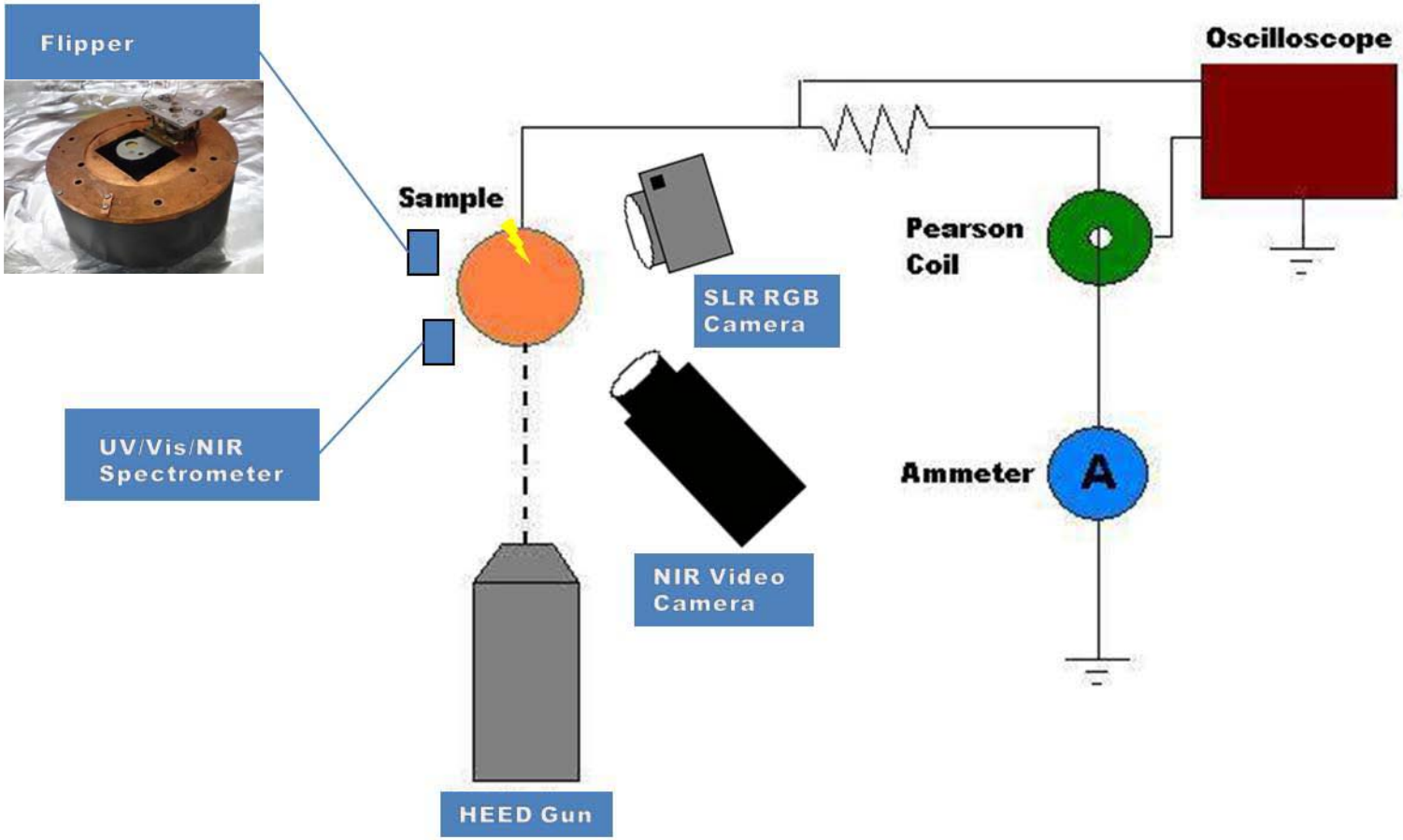
Charging of Materials in the Space Environment

- Electrostatic discharge is the leading cause of spacecraft failure due to the space environment

Experimental Design



Experimental Setup

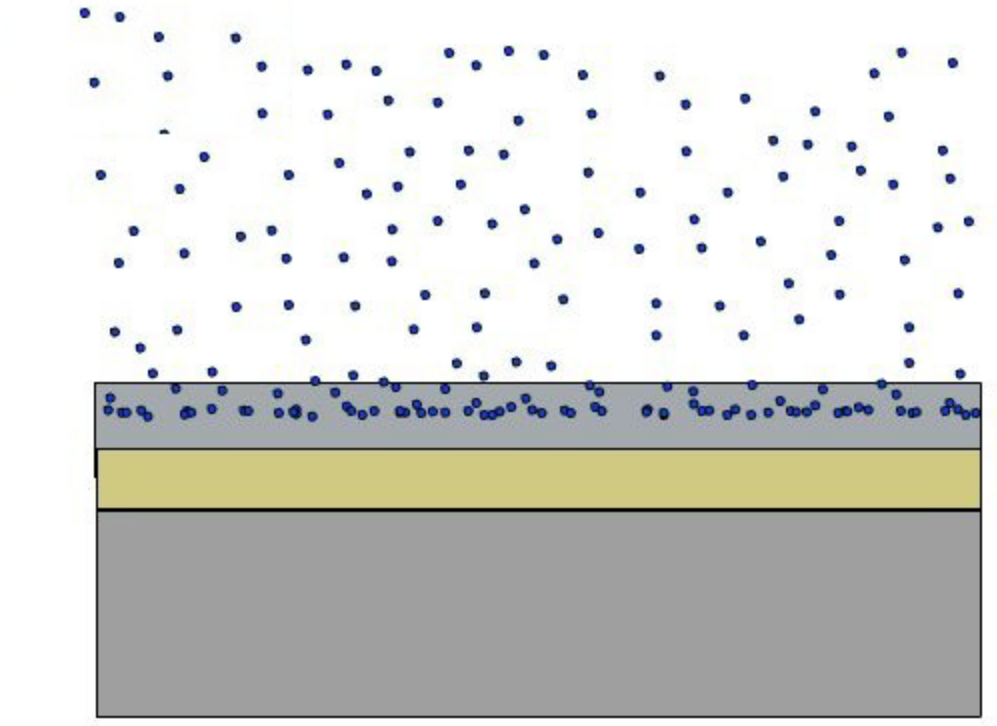


Internal Charge Evolution

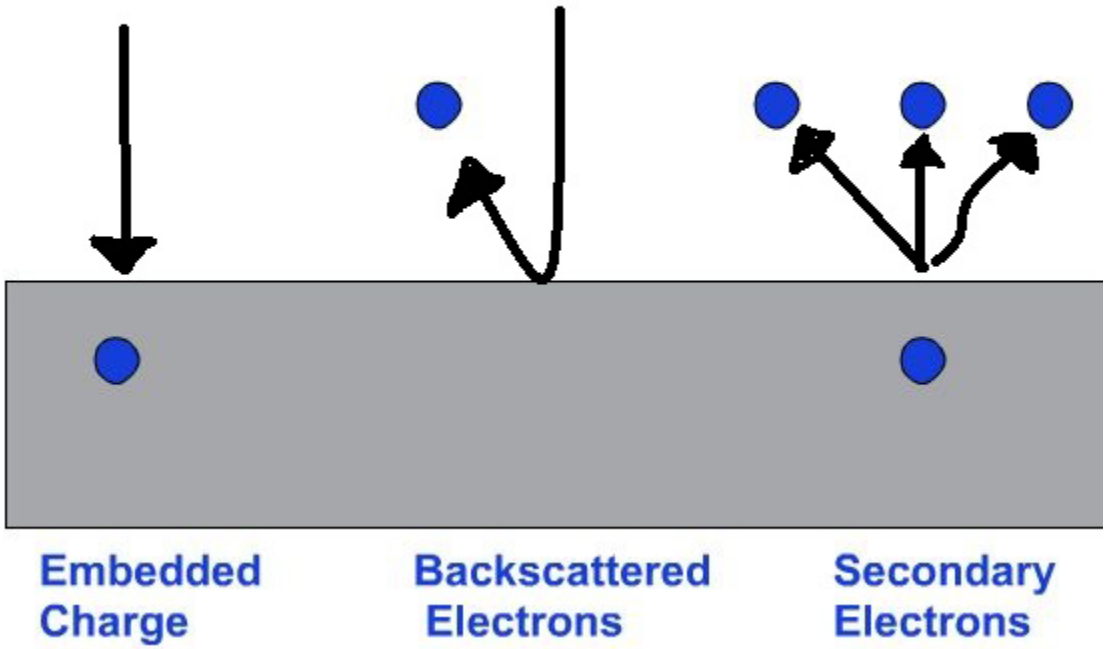
- Range
- Electron Yield
- Conductivity

Range

- Depth electrons penetrate is energy dependent

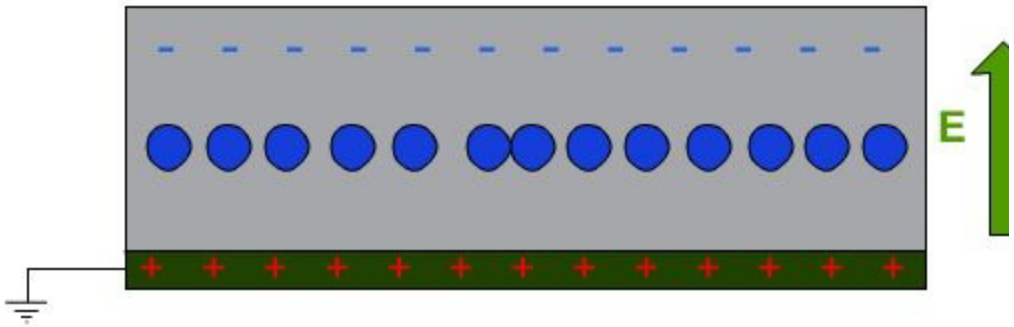


Electron Yield



Conductivity

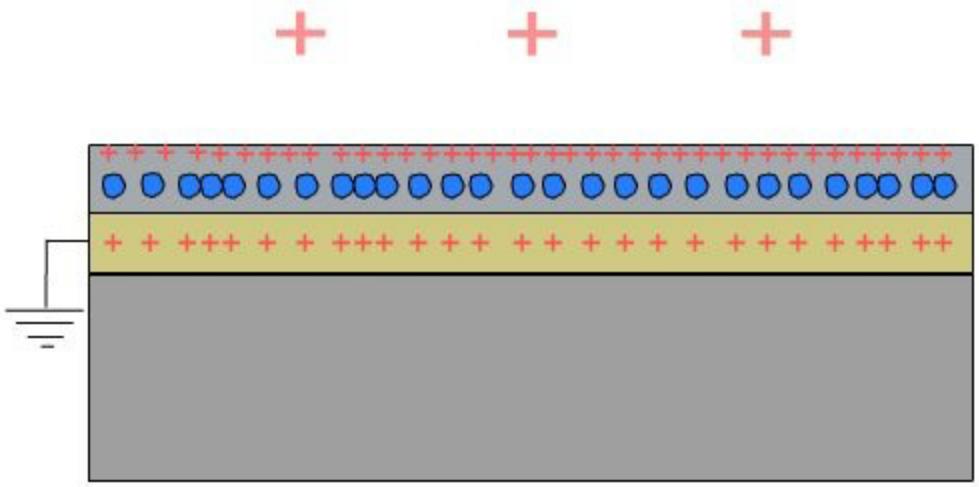
- Conductivity determines deposited charge layer movement



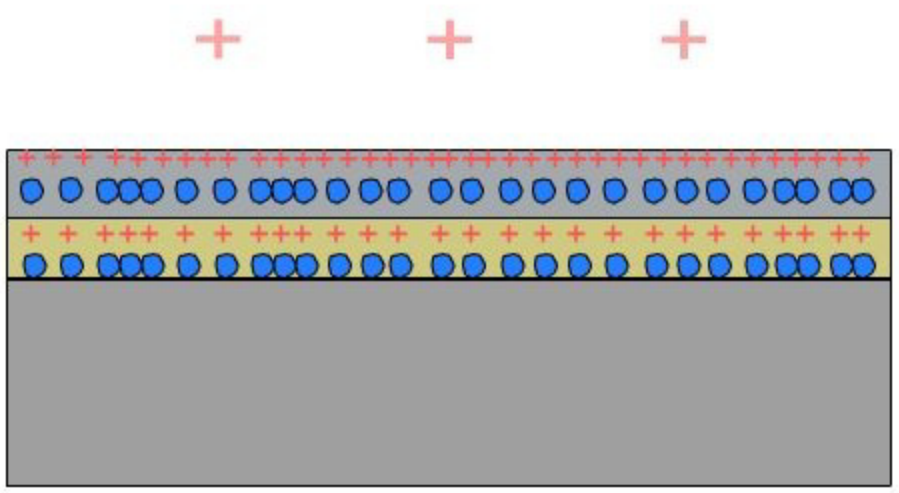
Charging Scenarios

- Low Energy
  - Grounded
  - Ungrounded
- High Energy
  - Grounded
  - Ungrounded

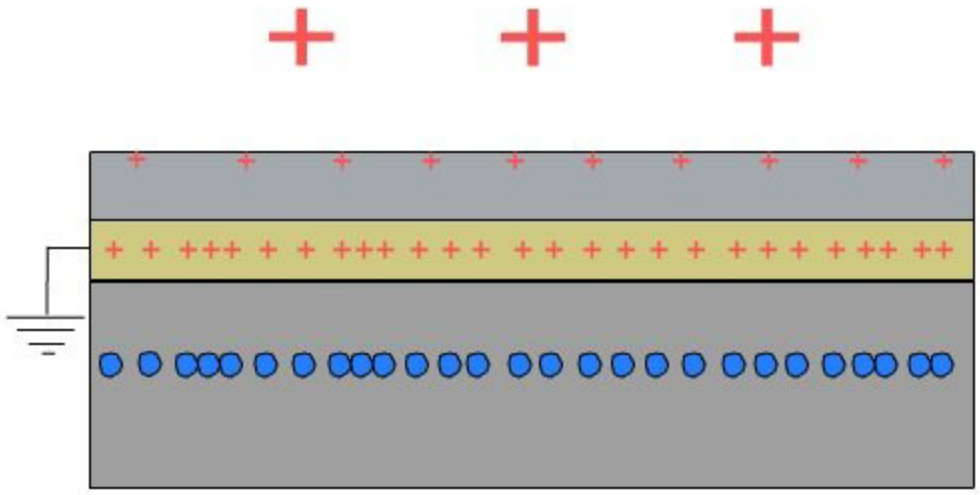
Low Energy - Grounded



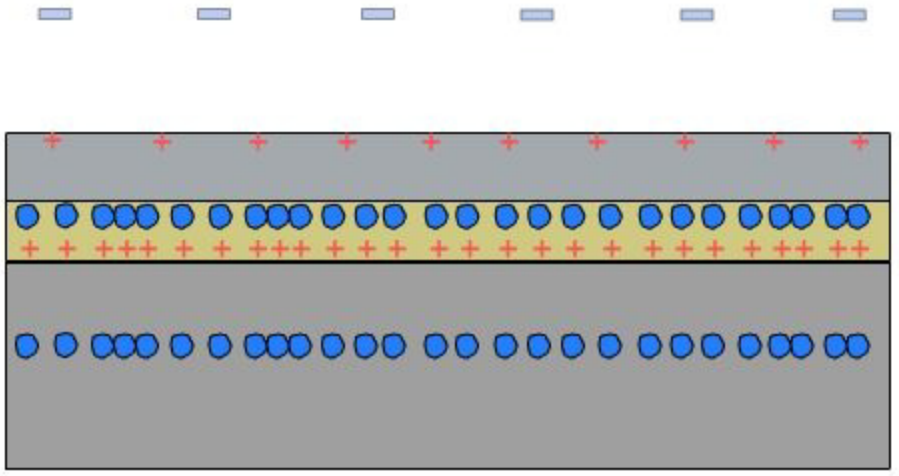
Low Energy - Ungrounded



High Energy - Grounded



High Energy - Ungrounded



Electrostatic Discharge

- High negative net potentials led to breakdown and arcing

In Conclusion We Observed:

- The charging of materials is dependent on the incident electron energy (through the range and electron yield) and conductivity of the material

$$V_s = \frac{\bar{J}_0[1 - Y(E_b)]}{\sigma_{DC}} R(E_b) \frac{[D - R(E_b)]}{D}$$

- Internal conductive layers, if grounded, can mask deep internal charging

- High negative net surface potentials resulted in electrostatic discharge

In Conclusion We Observed:

- These measurements and models allow the quantization and assesment of the charging of multilayered dielectric optical materials due to the space environment