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Charging Effects of High Voltage Probe Pulse on Pulsed Electroacoustic Measurements

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Charging Effects of High Voltage Probe Pulse on Pulsed Electroacoustic Measurements

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Overview

• Pulsed Electroacoustic (PEA) Method
• Importance of PEA
• Charging
• Potential Problem
• Measurements
• Conclusions
What is PEA?

How it works:
- Pulsed voltage probes embedded charge
- Time of flight indicates position of charge

Benefits:
- Nondestructive measurement
- Low cost
- High resolution

Limitations:
- Instrumentation bandwidth
- Electronics for higher resolution are costly

L. Pearson (2017)
Importance of PEA

Spacecraft Charging
• A majority of space environment-induced failures are due to spacecraft charging
• Length scales from 1-100’s of µm

Applications:
• HV power cabling insulation
• HV devices and switches
• Electrostatic charging in accelerators and plasma chambers
• Plasma deposition
• Thin film dielectrics
• Electron microscopy and spectroscopy
• Photoconductive devices/sensors
• Inferring defect states in materials
• **Spacecraft charging**
• Anything that has a stored charge
Our PEA System

Specs:
- 0-10 kV DC voltage
- 0.5-5 ns pulse width
- 1-2 kV reference voltage
Charging

• Electrode Charging

• Electron Irradiation
The Problem: Charging from the probing pulse?

Electrode charging from high voltage probe pulses?
• Can we measure the charging (if any) caused from the HV pulses?

This presumably depends on
• Electric field applied to the sample (amplitude of signal)
• Length of time applying electric field
Measurements

- Material used for tests are 250 μm thick polymethylmethacrylate (PMMA)
- New sample used for each measurement
- Various pulse generator settings were used with and without DC bias

<table>
<thead>
<tr>
<th>Measurements taken</th>
<th>Amplitude (V)</th>
<th>Pulse Width (ns)</th>
<th>Pulse Rate Frequency (Hz)</th>
<th>Length of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 kV DC Bias</td>
<td>1000</td>
<td>0.5</td>
<td>20</td>
<td>30 min</td>
</tr>
<tr>
<td>8 kV DC Bias</td>
<td>1500</td>
<td>2.5</td>
<td>20</td>
<td>30 min</td>
</tr>
<tr>
<td>8 kV DC Bias</td>
<td>2000</td>
<td>5</td>
<td>20</td>
<td>30 min</td>
</tr>
<tr>
<td>No DC Bias</td>
<td>1000</td>
<td>0.5</td>
<td>20</td>
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<td>30 min</td>
</tr>
<tr>
<td>No DC Bias</td>
<td>2000</td>
<td>5</td>
<td>20</td>
<td>20 hours</td>
</tr>
</tbody>
</table>
8 kV DC Bias: 1000 V 0.5 ns 20 Hz for 30 minutes

Charging is apparent near the HV electrode peak

Flipped the sample over
8 kV DC Bias: 2000 V 5 ns 20 Hz for 30 minutes

Charging is apparent near the ground electrode peak

Flipped the sample over
8 kV DC Bias: 2000 V 5 ns 20 Hz for 30 minutes (#2)

Charge is again apparent near the ground electrode peak

Flipped the sample over
No DC Bias: Continuous measurements for 30 min

1000 V 0.5 ns 20 Hz Pulse

1500 V 2.5 ns 20 Hz Pulse

2000 V 5 ns 20 Hz Pulse

No apparent charging after 30 minutes on any pulse setting
No DC Bias: 2000 V 5 ns 20 Hz for 20 hours

Still no apparent charging after 20 hours of continuous measurements at the max settings of pulse generator.
Conclusions

• No measurable charging due to probing pulse
• Charge packet is either negative near ground electrode or positive near HV electrode

Future work:
• Apply DC bias without taking measurements and compare to samples probed while charging
• Investigate effects causing positive/negative charge packets
Questions?