Laboratoire Plasma et Conversion d'Energie

Signal processing of a pulsed electroacoustic cell

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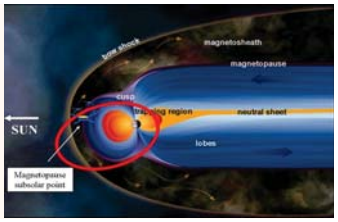
Overview

Satellites contain dielectric materials for various reasons :

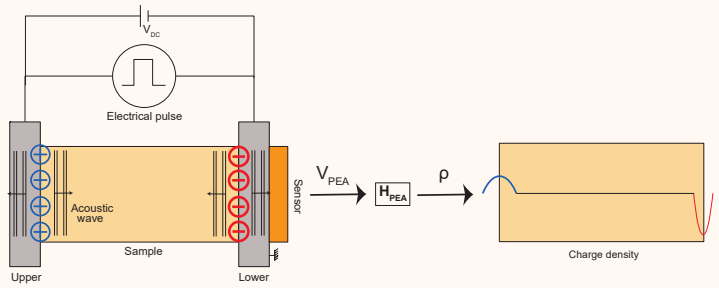
- Thermal insulation of satellite using PI-Kapton thermal blanket
- Electrical insulation of internal electronic devices using PTFE-Teflon

Dielectric materials into space environment and diagnostic methods

- Dielectric materials are exposed to the solar particles
- Charge accumulation on the external dielectric of the satellite depending on the energy of particles and material behavior
- Charge accumulation leads to the local electric field increase responsible for numerous satellite failures



PEA principle



Experimental setting :

- PTFE-Teflon sample
- $205\ \mu m$ thickness
- $1\ kV$ biasing
- $5\ ns$ width Gaussian Pulse

How the space charge is currently retrieved ?

- The transfer function is totally defined by the impulse response of only one pic of the output tension of the system: $H_{PEA} \cdot \rho = V_{PEA}$ ★
- The attenuation and the dispersion of the sample are not taken into account
- The effect of the reflection between the upper electrode and the sample are not taken into account

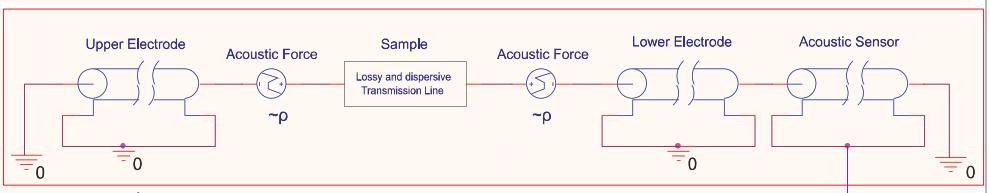
Aim of the PhD

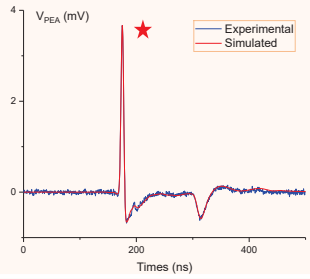
- Building a new transfer function to retrieve the space charge
  - By using a model taking into account the attenuation and the dispersion of the acoustic wave through the sample
  - By discretizing the sample to define the impulse response for each slice of the sample

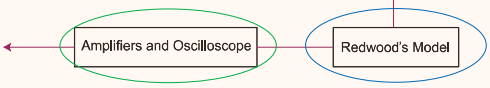
PEA Model

Electroacoustic equivalence

- Acoustic propagation is modeled by transmission lines using electroacoustic equivalence
- The attenuation and the dispersion of the sample are measured from the well known experimental signal and then modeled by Nearly Local Kramers-Kronig relations
- The sample is modeled by a frequency dependent lossy transmission line







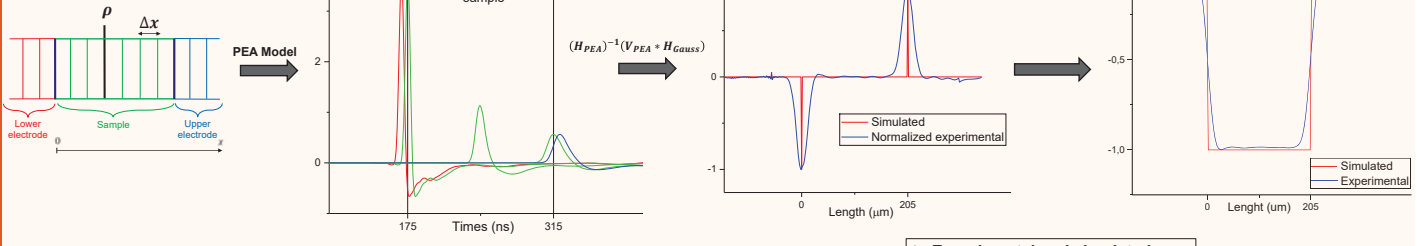
Acquisiton chain

Model of the electric → acoustic transformation

The simulated signal is optimized by the least squares method respecting plausible values of optimized parameters

Transfer function

Discretization of the sample → **Transfer function construction with an hypothesis Dirac input** → **Deconvolution of simulated and filtered experimental signal using Tikhonov regularization** → **Integration of the space charge to get the electric field inside the sample**



- **Experimental and simulated charge are almost centered**
- **Less spatial resolution for the experimental charge because of the Gaussian filter.**

CONCLUSIONS :

- ✓ Acoustic attenuation and dispersion are modeled with NLKK relations for polymers
- ✓ The function transfer of the PEA is now taking care of the effect of the acoustic reflection

PERSPECTIVES :

Applying the previous process to retrieved space charge from signal of no-connection PEA, « thin sample » or multi-layer

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