Introduction

- Pulsed RF plasmas present complex load terminations that change on the μs time scale, making power matching very challenging.
- By measuring the dominant impedance contributions to RF plasmas (electron density and sheath thickness) as a function of time, impedance trajectories can be mapped for closed loop power control.
- By correlating these parameters to electrical impedance measurement, empirical models can also be developed for real time monitoring and process control within the pulse waveform.

Initial measurements show that dominant impedance shift during pulse transient may not be from sheath reactance as originally expected, but may instead come from the change in bulk plasma impedance due to electron density changes.

Experimental Characterization

Results

Data was taken using optical emission spectroscopy (OES), RF compensated Langmuir probe, and a VI probe. Phase locked images were used to estimate sheath thickness (and thereby capacitive reactance) to compare with electrical measurements from the VI probe.

Discussion

Data was then taken using OES. The data was summed and plotted. The position of the sheath was then measured. Neither the powered sheath or the grounded counter sheath showed significant change during the pulse on/off cycles.

To corroborate this data was then taken with a VI and Langmuir probe and sheath thickness was calculated using a uniform global discharge model for argon. As seen from the graphs below sheath thickness varies slightly with respect to pressure power and gas composition; electron density and sheath voltage measurements taken with independent diagnostics show similar stagnant sheath thickness during the pulse cycles.

Argon has a fairly constant sheath thickness with respect to power. For a 50 50 argon oxygen mix the results are still fairly constant at high powers. After 70W sheath thickness increases as power decreases. We are unsure of why the addition of oxygen causes a difference in the trends of sheath thickness. These differences were not seen in the OES data because the resolution is not that accurate. For the OES data 1 pixel is equal to 0.0577mm.

Future Work

- Sheath thickness is fairly constant with respect to power and pressure. Changes in plasma impedance are primarily due to changes in electron density. This was not expected based on previous findings it was expected that sheath reactance would dominate.
- Examine the sheath thickness at different frequencies and look more into the step functions.
- Realign the camera for OES data with more accurate results.
- Build a model of the plasma during the off cycle.
- Introduce a second generator at a low power and make more measurements of the plasma parameters during the off cycle of the pulse.

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References