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カーリングプローブによるパルス変調プラズマの時分解密度測定 II

Time-resolved Density Measurement of Pulse-modulated Plasma by Curling Probe II

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1) Introduction

Curling Probe is a modified form of microwave resonator probe that enables electron density measurement even when insulating film is deposited on the probe surface. Results of curling probe measurement in pulsed discharge of 400Hz were previously reported. This time we want to report the results in higher pulsed frequencies, i.e, 1 kHz, 3 kHz with varying duty cycle ratios. Also, comparison of curling probe measurement with Langmuir probe and time evolution of optical emission from the pulsed modulated plasma will be reported.

2) Experiment and Results

Curling probe measures electron density based upon the resonance frequency shift between plasma OFF and ON conditions. Unlike a steady state plasma, the electron density in a pulsed modulated plasma varies with time. This variation continues even in the time period when the frequency is being swept by the network analyzer (NWA). Therefore, the NWA must be synchronously triggered with the discharge pulse to obtain an intelligible resonance signal.

At higher pulse frequencies temporal variation of electron density is very rapid. It was observed that chances of picking up spurious resonance signals greatly increases under such conditions. So, synchronization along with data averaging was carried out to minimize data scattering and accurately measure electron density.

Experiments were carried out in 1 kHz pulse discharge with duty cycle of 11% in N_2 gas pressure of 10 Pa. The NWA was operated in external trigger mode and the sweep time was delayed on steps 20μsec to obtain electron density change with time. Fig.1 shows the resonance spectra obtained for a pulse of 1 kHz with duty cycle ratio of 11%. The same experiment was repeated for a duty cycle ratio of 33%.

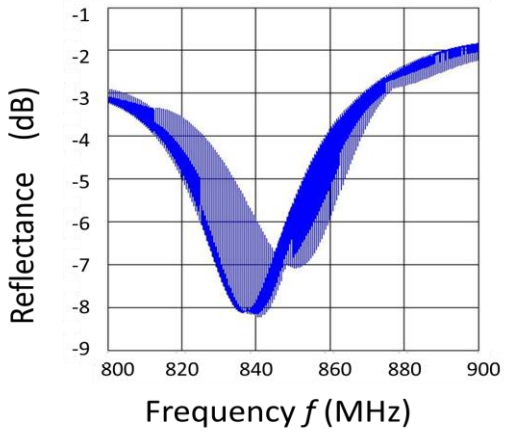

Fig.1 Resonance spectra obtained for pulsed freq. 1kHz

Fig.2 displays a comparison of electron density evolution in duty cycle ratios of 11% and 33%.

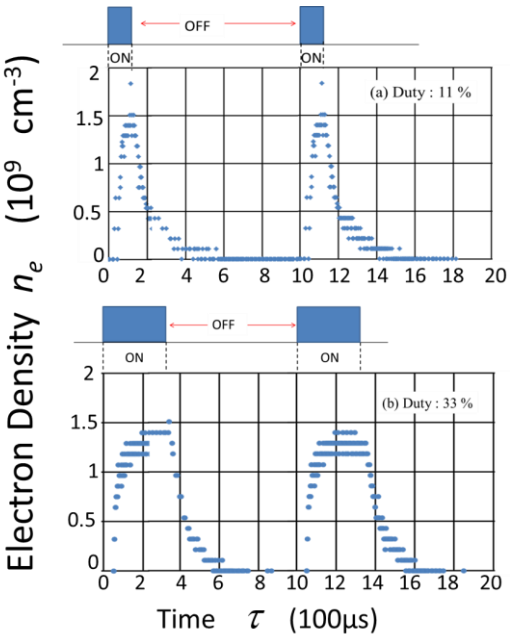

Fig.2 Comparison of electron density variation