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カーリングプローブによる高周波変調プラズマの時間分解密度測定

Time-resolved Curling Probe Measurement of Plasma Modulated at High Frequency

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1) Introduction

Curling probe (CP), a modified form of microwave resonator probe can measure electron densities even in reactive deposition plasmas. In the last year's JSAP Autumn Meeting we presented the time-resolved electron density measurement in pulse-modulated plasma up to 10 kHz. In this meeting, we would like to present our data up to modulation frequencies of 25 kHz, comparing the density decay time in afterglow for different gas species.

2) Experiment

We have previously reported about the measurement technique of electron density in pulsed-modulated plasma by synchronization of discharge pulse with network analyzer (NWA) sweep time. Such synchronization can be done in two ways, namely *on sweep* and *on point* modes. *On sweep* mode is suitable for measurement of electron densities in plasma generated at such low pulsed frequencies as 1 kHz.

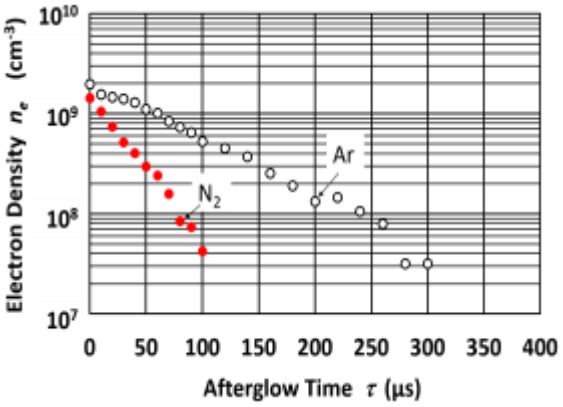

Fig.1. Electron density variation in after-glow plasma.

Electron density variation after the discharge OFF (afterglow) for different gas species was investigated. The experiments were performed in a pulsed discharge of 1 kHz, duty 30 % at a pressure of 40 Pa. Fig. 1 shows the electron density variation with afterglow time for Ar and N_2. The density was observed to decrease in a decay time of 20 ~ 100 μs. The dependence of decay time on gas species will be discussed.

On the other hand, *on point* measurement is applicable for the modulation frequencies ≥ 1 kHz. For example, the electron density in a pulse modulated plasma at 15 kHz duty 50% in N_2 gas at 10 Pa was investigated as shown in Fig. 2.

It should be noted in Fig. 2(a) that the discharge voltage does not drop to zero but continues at -200 V. As a result, the plasma does not disappear even at a time of such low discharge voltage, and is sustained to the next cycle. Thus, the electron density was modulated in time at a level of 40 %, as shown in Fig. 2(b).

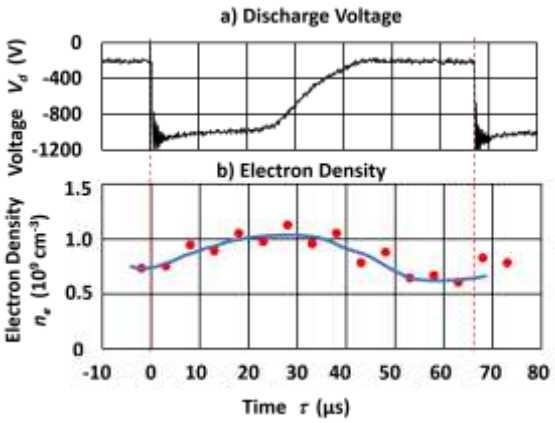

Fig. 2. Electron density measurement at 15 kHz modulation