Effects of amplitude modulated VHF discharge on coupling between plasmas and nanoparticles

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Fluctuation of interactions between plasmas and interface in a nanometer scale is crucial to realize precise control of nano-fabrication using plasmas, because such interactions determine characteristics of nanomaterials. To study the interactions, we have perturbed radical density by amplitude modulated VHF discharges and have measured amount of nanoparticles in plasmas. Nanoparticles were generated using capacitively coupled Ar + $Si(CH_3)_2(OCH_3)_2$ discharges and were detected with a two-dimensional laser light scattering system [1, 2]. To generate discharge plasmas, high frequency voltage of 60 MHz was applied between the powered and grounded electrodes. The amplitude modulation frequency f_{AM} was 100 Hz. The amplitude modulation level was from 10 % to 50 %. We have obtained power spectrum of the fluctuation particle amount in plasmas by the Fast Fourier Transform of the time evolution of the fluctuation. The fluctuation peaks in the power spectra exist not only at f_{AM} and its higher harmonics but also at its subharmonics. Radical generation rates deduced by optical emission spectroscopy are fluctuated at f_{AM} and its higher harmonics. Our theoretical study on the particle amount fluctuation predicts that the particle growth rate is coupled with the radical density and the particle amount is fluctuated at 3/5 of the radical density fluctuation frequency [3]. Our experimental results show that the particle amount is fluctuated at 3/5 f_{AM}. Figure 1 shows AM level dependence of the power at 3/5 f_{AM} normalized by the power at f_{AM}. The normalized power decreases exponentially with increasing the AM level, showing that this coupling depends on the AM level. The behavior of the coupling,will be discussed in this presentation.

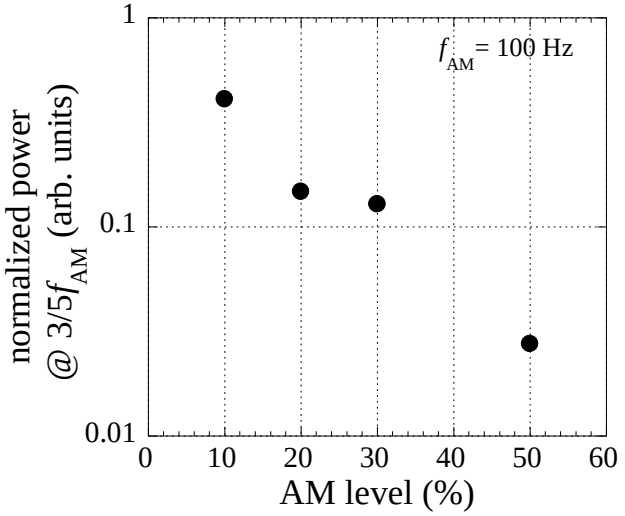

Fig. 1. AM level dependence of normalized power of the particle amount fluctuation at 3/5 f_{AM}.

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