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# 放電電力変調反応性プラズマにおけるナノ粒子成長の時空間構造の観測
# Observation of Spatio-Temporal Structure of Growth of Nano-Particles in Reactive Plasmas with Discharge Power Modulation

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## 1. Introduction

To fabricate nano-composite films in many fields includeng ULSI production, plasma processing is widely used as a very useful tool [1]. Nano-particles are often generated in the gas phase of the reactive plasmas. They may have harmuful effects on some processes, whereas they can be employed as usefull nanoblocks in other processes. Interaction between plasma fluctuations and growth of nano-particles in reactive plasmas should be taken into account for more explosive development of fabrication technology of nano-materials and nano-structures since such impacts of nano-particles on the plasma fluctuations exist in the dust plasma [2].

Here, We report observations of spatio-temporal structures of amount of nano-particles in reactive discharge plasma without amplitude modulation (AM) and with AM using an in-situ two dimensional laser light scattering (LLS) method with a high speed camera.

## 2. Experimental

The size of the CCP reactor and electrodes are the same as those in Ref. 3. The reactor was evacuated to a base pressure of less than $10^{-3}$ Pa with a rotary pump and a diffusion pump. The flow rates of $Si(CH_3)_2(OCH_3)_2$ and Ar were 0.2 and 40 sccm, respectively. The total gas pressure in the reactor was 133 Pa. The temperature of the reactor wall was maintained at 373 K in order to avoid the liquefaction of $Si(CH_3)_2(OCH_3)_2$. In order to generate nanoparticles, we sustained a discharge by applying 150 peak-to-peak voltage $V_{pp}$ of 60 MHz to the powered electrode. The spatio-temporal evolution of the LLS intensity between the upper grounded electrode and the powered rf electrode was obtained using an high speed camera (FASTCAM SA4: PHOTRON LIMITED) with a frame rate of 1000 $s^{-1}$.

## 3. Results and discussion

The spatio-temporal structures show that the amount of nano-particles with AM fluctuates simultaneously with high correlation in all ($z$, $t$) space, whereas those without AM fluctuates with low amplitude of fluctuation components, low correlation and no phase structure in all ($z$, $t$) space. There results indicate that narrow nano-particle size distribution is obtained by using AM.

## References

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