

## 反応性プラズマ中のナノ粒子量揺らぎの構造解析 Structure Analysis of Fluctuation of Nanoparticles in Reactive Plasma

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### 1. Introduction

Plasma processing is the important technology of “3D power scaling” for semiconductor devices and industry [1]. Interaction fluctuations between reactive plasma and nanostructures have a huge impact on such 3D nano-device fabrication. With the increase of the number of layers of 3D nano-devices, it is extremely important to comprehend and control the interaction fluctuations [2-4]. In this research, we study the time- and spatial-structures of fluctuations of nanoparticles in reactive plasma.

### 2. Experimental

We used a capacitively coupled plasma CVD reactor, as shown in Fig.1. DM-DMOS ( $\text{Si}(\text{OCH}_3)_2(\text{CH}_3)_2$ ) and Ar gas were supplied into the reactor at a flow rate of 0.2 sccm and 40 sccm. The total pressure was 1.25Torr. The RF discharge frequency and power were 60MHz and 30W. The discharge voltage was modulated at a frequency of 100Hz and the modulation level of 30% to perturb the plasma [3]. The period of discharge was  $T_{\text{on}} = 8$  s. The information of nanoparticles was obtained using two-dimensional laser light scattering (2DLLS) system employed with a high-speed camera (1000fps) [3]. The LLS intensity is proportional to nanoparticle density  $n_p$  and the sixth power of size  $d_p$  ( $\propto n_p d_p^6$ ).

### 3. Results

In our previous study [4], we applied envelop analysis to extract interaction fluctuation between nanoparticles and plasmas from the 2DLLS. Figure 2 (a) shows spatial profiles of intensity of LLS during the discharge around  $r = -27\text{mm}$  where is at the edge of plasma region. Figure 2 (b) shows spatial profiles of LLS fluctuations of 100Hz components during the discharge around  $r = -27\text{mm}$ . We can find the spatial-structure of nano-particle density fluctuation from the early time of the discharge ( $T_{\text{on}} > 1\text{s}$ ), though much nanoparticles are generated from  $T_{\text{on}} > 2\text{s}$ . These results suggest nano-particle fluctuations have influence on the generation of nanoparticles.

### References

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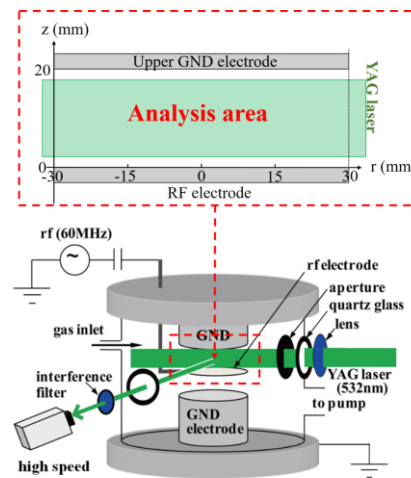


Fig. 1 Experimental apparatus and analysis area.

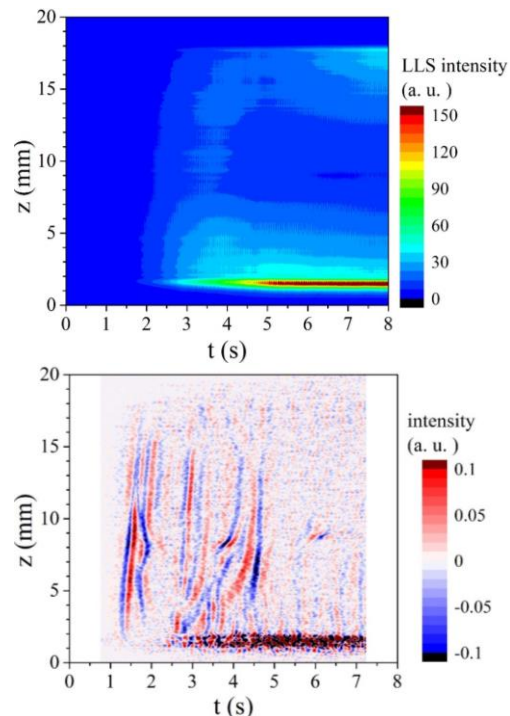


Fig. 2 Spatial profiles ( $r = -27\text{mm}$ ) of (a) LLS intensity and (b) interaction fluctuations of 100Hz components.