초기 실란 플라즈마 방전에서 발생한 나노 입자의 거동 분석

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Analysis of the behavior of nanoparticles generated in early silane plasma discharge

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1. Introduction

Reactive plasmas have been widely used in the field of material processing in the microelectronic industry such as surface treatment, semiconductor devices and photovoltaics. However, in reactive plasmas, particles are inevitably generated due to their gas phase reaction. Although much research has been done on behavior of particles, the relation between plasma parameters and experimental data concerning particle incorporation into film growth during the early stage of plasma discharge has not been reported. Furthermore, the contribution level of particles incorporated into film growth in the initial transient state of plasmas, i.e. from breakdown to steady state, has not been fully understood yet.

2. Experimental Method

We focus on the three different in-situ plasma diagnostics, which can readily be used in general PECVD experiments, namely optical emission spectroscopy (OES), Laser light scattering (LLS) technique and quartz crystal microbalance (QCM).

3. Results and Discussion

Characteristic behaviors of the time-dependent particle generation measured by the LLS in the early stage of silane plasma discharge have been investigated by using the OES and the QCM. In the regime where the amount of particles increase, time-dependent behaviors of plasma emission light such as SiH* and Si*/SiH* are not consistent with the particle amount measured by the LLS. Furthermore, time delay between the LLS and the QCM results is observed due to particle diffusion from the power electrode to surface of the QCM.

4. Conclusion

The time evolution of particle volume fraction, which are derived from the LLS and the QCM, provide continuous information on both film growth and particle incorporation from plasma ignition.

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