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Study on uniform plasma generation in Electron Cyclotron Resonance plasma etching reactor

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Recently, atomic level processing such as ALE and ALD is very important to manufacture next-generation ULSIs. Plasma etching device using ECR has been being widely used for ULSI manufacturing for years [1]. We studied uniform plasma generation mechanism in ECR plasma etcher to improve plasma controllability.

First, we observed very complicated electromagnetic field patterns in the chamber by microwave analysis of ECR plasma etcher and found it was originated from TG waves by its emerging condition and dispersion relation [3]. Next, we conducted plasma simulation, combining the microwave analysis with electron temperature and plasma diffusion analyses. We got consistent solutions of each analyses in practical calculation time. We compared the simulation results with the experimental ones of plasma distribution and found that both of them qualitatively coincided with each other. Furthermore, we studied the mechanism of uniform plasma generation in ECR plasma etcher, using the simulated results of microwave electromagnetic field and theoretical analysis of magneto-plasma filled waveguide. We discussed microwave propagation in magnetized plasma and, as a result, it became apparent that plasma of constant density can be enlarged, which is defined by microwave power absorption profile.

[1] K. Maeda, et al. Jpn. J. Appl. Phys. 51, 08HD01 (2012).

[2] D. G. Swanson, Plasma Waves (Academic Press, Inc., San Diego, 1989)

[3] H. Tamura, et al., to be published.