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A Novel Transmission line model of Cutoff Probe for precise measurement of high density plasma

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Cutoff probe, diagnostics instrument for plasma density, have been received an extensive attention due to simple, robust and lowest assumption. Although the cutoff probe has a long history, physical model is limited in low density plasma. For that reason, we propose a novel transmission line model of cutoff probe for precise measurement of high density plasma. In addition simplified circuit model can be obtained from transmission line model. It can explain simply physics of cutoff probe in high density plasma.

Keywords: microwave probe, cutoff probe, plasma diagnostics,

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Comparative simulation of microwave probes for plasma density measurement and its application

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The plasma density is an essential plasma parameter describing plasma physics. Furthermore, it affects the throughput and uniformity of plasma processing (etching, deposition, ashing, etc). Therefore, a novel technique for plasma density measurement has been attracting considerable attention. Microwave probe is a promising diagnostic technique. Various type of cutoff, hairpin, impedance, transmission, and absorption probes have been developed and investigated. Recently, based on the basic type of probes, modified flat probe (curling and multipole probes), have been developing for in situ processing plasma monitoring. There is a need for comparative study between the probes. It can give some hints on choosing the reliable probe and application of the probes.

In this presentation, we make attempt of numerical study of different kinds of microwave probes. Characteristics of frequency spectrum from probes were analyzed by using three-dimensional electromagnetic simulation. The plasma density, obtained from the spectrum, was compared with simulation input plasma density. The different microwave probe behavior with changes of plasma density, sheath and pressure were found. To confirm the result experimentally, we performed the comparative experiment between cutoff and hairpin probes. The sheath and collision effects are corrected for each probe. The results were reasonably interpreted based on the above simulation.

Keywords: plasma density, em simulation, plasma processing monitoring, microwave probe