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**Development and Miniaturization of RF based probes for Electron Density Measurements**

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To make a diagnostics on plasmas for materials processing plasmas accompanying with deposition of non-conducting films in etching and/or CVD processes, curling probe (CP) with a spiral slot antenna has been recently developed as a compact diagnostic tool which enables the local electron density measurement. The electron density is obtained from a shift of the probe resonance frequency in discharge ON and OFF monitored by a network analyzer (NWA). A conventional CP has a diameter larger than ˜15 mm typically, because a slot length of the CP is as long as several tens millimeters for its resonance frequency less than several GHz. Further miniaturization of the CP was required to expand applicable range to various plasma sources like a narrow-gap parallel plate discharge. We tried miniaturization of the CP down to less than ˜3 mm in the probe diameter by fabricating narrow spiral slot antenna, and experimentally and numerically the miniaturized probe was investigated how much influence the slot width has on probe resonance characteristics and electron density measurements. In the case of the conventional CP made of stainless steel, ˜0.3-mm-wide normal slot antenna, the resonance spectra was clearly observed regardless of antenna materials of copper or stainless steel (SS). However, when the slot width was reduced down to ˜0.03 mm, the slot resonance was strongly dependent on the antenna materials. Namely the resonance peak was almost vanished for the SS antenna, whereas clearly appeared for the copper antenna. In general, the narrower the slot is, the higher attenuation factor the slot has for electromagnetic wave propagating along the slot. In such an attenuated transmission line of the narrow slot, high electric conductivity of the antenna seems preferable for the slot resonance. Furthermore, the miniaturized CP with the copper antenna was also introduced into low pressure (<˜1Pa) Ar plasma. The resonance frequency was confirmed to changes sensitively with electron density, suggesting the miniaturized CP will be available to electron density measurements. Numerical simulation showed that localization of electromagnetic fields near the slot was remarkably enhanced by decreasing in the slot width, suggesting that the miniaturized CP suffers from more significant sheath effects compared to the conventional CP.