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容量性結合型プラズマにおける 高精度プラズマインピーダンス測定に関する研究
High-precision plasma impedance measurement in capacitively coupled plasmas

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High value-added products with large-scale integration circuit such as vehicle components require high quality and reliability. The real-time monitoring method should be used to detect defective products for high quality and reliability productions. The plasma measurement system which has characteristics of non-invasiveness, high-precision and simple-structure is necessary for monitoring the production line. This study focuses on plasma impedance measurement (PIM) to achieve high-precision plasma monitoring. The PIM has been used for the end point detection in etching processes [1,2] and has already been put to practical use in production lines. The aim of this study is the further development of the PIM method which can detect the plasma impedance changes in the very short time (microseconds).

Figure 1 shows a schematic drawing of our device. The plasma is generated by a conventional capacitive coupled discharge. The excitation frequency is 13.56 MHz (input RF power: 100-600 W). The working gases are SF_6 (gas flow rate: 100 sccm) and N_2 (gas flow rate: 6 sccm) with a pressure of 18 Pa. The signals of the forward and reverse powers with phase information are obtained by use of the directional coupler, which is connected in series between the matching circuit and the RF power supply. The signals are calculated using the Cross Domain Analyzer ™ U3841 for high-speed vector processing.

Figure 2 shows the time variation of the plasma impedance and the voltage reflection coefficient (VRC). They are averaged over 256 points in a time interval of the order of microseconds. While the plasma is not generated ($t \lesssim 3$ sec and $t \geq 15$ sec), all error bars are very large. After approximately 10 seconds of plasma generation, the imaginary part of the plasma impedance and the VRC change drastically as the plasma parameters changes with wafer oscillation. The conventional PIM could not detect such plasma impedance changes with wafer oscillation because of the phase delay of the current probe. Our PIM can precisely measure the changes in the plasma impedance with wafer oscillation. The wafer oscillation on the stage causes the defective products owing to the disconnected wiring.

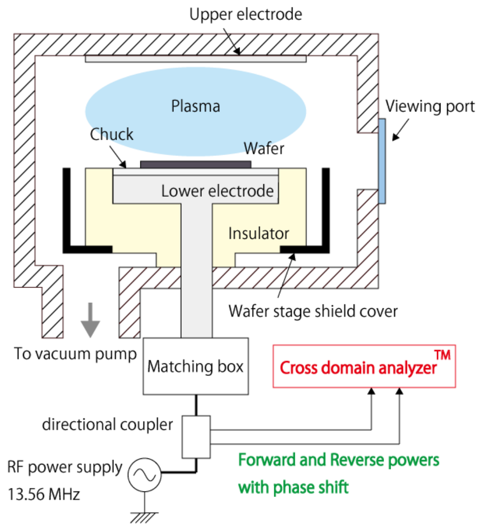

Fig. 1: Schematic drawing of our device.

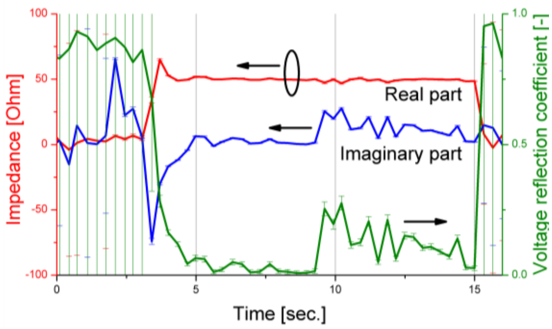

Fig. 2: Changes in the plasma impedance and the voltage reflection coefficient by wafer oscillation.

Our results suggest that our PIM method can be effective for non-invasiveness, high-precision, simple-structure, and high-speed measurement in the production line. We will perform synchronous measurement with the fundamental plasma parameters in the near future.

[1] M.N.A. Dewan *et. al.*, Microelectronic Engineering Vol. 65, pp. 25-46 (2003).
[2] S. Kanno *et. al.*, Jpn. J. Appl. Phys., Vol. 43, pp.1199-1204 (2004).