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プラズマ照射によるタングステン表面変化の分光エリプソメトリー測定

In-situ Spectroscopic Ellipsometry Measurement of Change in Tungsten Surface Due to Plasma Exposure

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1. Introduction

The surface condition of the plasma-facing material continues to change due to Plasma-surface interaction (PSI) such as radiation damages, erosion and deposition. In order to understand PSI phenomena, real-time measurement of the surface modification is necessary. In-situ spectroscopic ellipsometry is an effective method to diagnose structure of the surface by measuring the phase difference (Δ) and the amplitude ratio (Ψ) of the reflected light from a target sample. In this study, we evaluate Δ and Ψ of the tungsten surface during the plasma exposure in a compact linear plasma device (APSEDAS). We have introduced an optical shutter into the spectroscopic ellipsometry system to distinguish between the plasma emission and reflected light.

2. Experimental procedure

A target sample is fixed on the water-cooled stage in APSEDAS. The target square sample is polycrystalline tungsten whose length of a side and thickness are 10 mm and 1.0 mm, respectively. The spectroscopic ellipsometry system consists of a xenon lamp, a rod lens, an optical shutter, a polarizer, a target sample, a rotation analyzer, a zoom lens, and a spectrometer. The tungsten sample was exposed to deuterium plasma and changes in Δ and Ψ were measured with spectroscopic ellipsometry.

3. Experimental result

Figure 1 shows optical intensity depending on angle of rotating analyzer during plasma exposure using the spectroscopic ellipsometry system. The blue dot represents optical intensity of the background light mainly from plasma emission and the red dot represents total optical intensity of the reflected light from the sample and the background light. Therefore the intensity of the reflected light from the sample is obtained by subtracting the optical intensity when the shutter is closed from that when the shutter is open. Figure 2 shows the values of Δ and Ψ of reflected light from the tungsten sample before, during and after plasma exposure in the wavelength range of 450-800 nm. The value of Δ rises immediately after the plasma ignition and there is small change of Δ and ψ immediately before and after the plasma is extinguished. In this measurement, the values of Δ and Ψ are obtained every 72 s during plasma exposure.

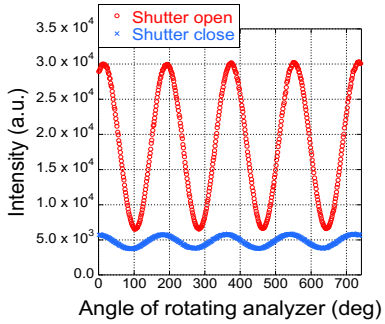

Fig.1. Optical intensity depending on angle of rotating analyzer for the wavelength of 555 nm during plasma exposure.

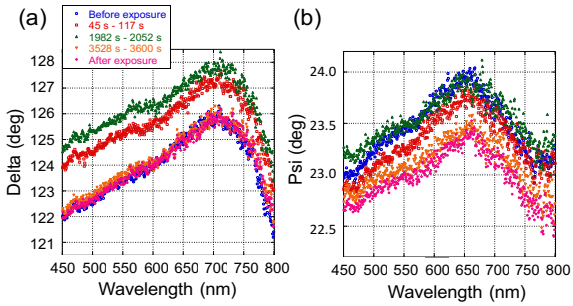

Fig.2. Values of (a) Δ and (b) Ψ depending on wavelength.

4. Conclusion

In this research, we introduced an optical shutter to spectroscopic ellipsometry system for understanding PSI phenomena. The values of Δ and Ψ of reflected light from the tungsten sample is measured in the wavelength range of 450-800 nm during the deuterium plasma exposure.