Surface Differential Reflectance Spectroscopy in Reactive Magnetron Sputtering

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1. Introduction

Low temperature plasma involved in plasma-based deposition processes, such as reactive magnetron sputtering, are difficult to characterize in terms of its local plasma parameters. An in-situ, noninvasive diagnostic technique can clarify the mechanism of film growth and erosion in reactive plasma, particularly when strong adsorption behavior in the gas is present. One possible method to diagnose plasma immersed surface conditions would be surface differential reflectance spectroscopy (SDRS). The change in the intensity of the reflected light, as based on the Eq. 1, can determine the change on the surface with respect to an initial state. Time-resolved changes to the surface, of up to 10-20 nm depth can be identified [1].

$$\frac{\Delta R}{\bar{R}} = \frac{I(E,t) - I(E,0)}{I(E,0)} \quad \text{(Eq. 1)}$$

where I = intensity, E = photon energy

2. Methodology

The reactive magnetron sputtering schematic is shown in Fig. 1. A DC magnetron sputtering system will be designed to accommodate laser incident at 65°, at both the Zn target and substrate. A USB spectrophotometer will be utilized to record the changes in the observed signal.

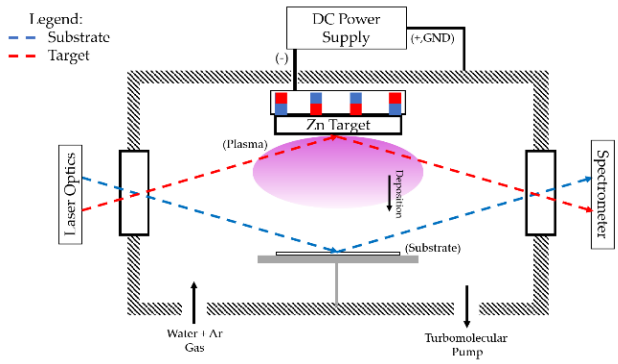

Fig. 1 Schematic diagram of the SDRS setup in a reactive magnetron sputtering system

Reactive DC magnetron sputtering will be carried out in varying argon to water vapor (Ar-H_2O) ratios, with metallic Zn as the sputtering target.

3. Results

Initial optical emission spectra, as shown in Fig. 2, were obtained for the Ar-H_2O plasma, to determine the ideal laser wavelength at which SDRS can be performed. This was collected using a 70-mm target diameter reactive DC magnetron sputtering system, perpendicular to a Zn metal target, at 1.0 Pa and 100 mA discharge current.

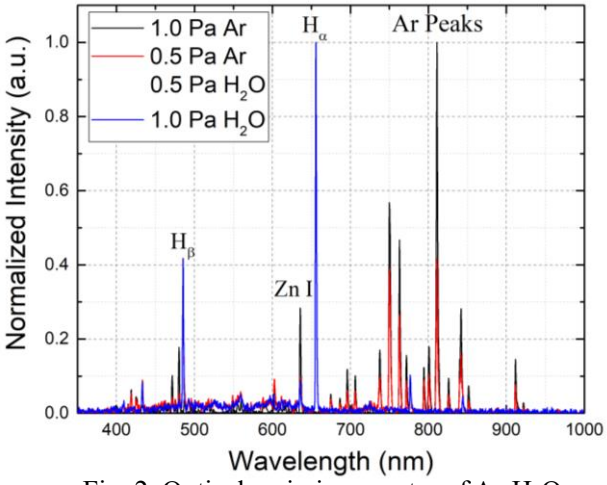

Fig. 2. Optical emission spectra of Ar-H_2O plasma at different partial pressure

Changes in the measured peak intensity, due to fluctuations in the plasma, can affect the reliability of the SDRS results. Thus, the presence of H_α and Ar peaks limits the laser wavelength to the <600 nm region. The SDRS experiments will then be performed using continuous wave (CW) lasers of 405 nm and 532 nm.

References

[1] A. Navarro-Quezada, M. Aiglinger, E. Ghanbari, Th. Wagner, and P. Zeppenfeld. Rev. Sci. Instrum. **86**. 113108 (2015)