A study on the characteristics of hollow cathode discharge for the development of VUV lamp

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The VUV light source can provide a variable for measuring the density of oxygen based on the theory of the absorption spectroscopy. The VUV light source consists of hollow cathode biased by negative voltage and grounded plate to generate high density plasma. Characteristic of hollow cathode is one of the important variables of the VUV light source, which affects the performance of light sources according to the characteristic of the gas-discharge light source. The characteristics of plasma discharge were determined by checking the composition of the molecules and the composition of the particles according to the electrical characteristics and the wavelength of the cases by using optical emission spectroscopy, and the plasma temperature was measured accordingly. In particular, it was confirmed that the possibility of controlling the plasma VUV light in the 130 nm wavelength region was verified, and the possibility of using the plasma discharge as a VUV lamp was verified.

1. Introduction

Ultraviolet(UV) is an electromagnetic radiation with a wavelength from 10nm to 400nm, shorter than that of visible light but longer than X-rays. Long-wavelength ultraviolet radiation can cause chemical reaction and causes many substances to glow or fluoresce. Ionized gas is macroscopically neutral that contains ions, electron, neutral, photon and radicals. The parameters of UV absorption spectroscopy are supported to etch rate, offering potential for control and optimization of semiconductor processing. A hollow cathode lamp is type of lamp used in physics and chemistry as spectral line source and as a frequency tuner for light sources such as lasers. Atomic absorption lines are very narrow. For the Beer-Lambert law to be applicable, the bandwidth of the source should be narrow in comparison with the width of the absorption peak. Otherwise, the signal-to-noise ratio and the slope of the calibration curve would be low; the resulting sensitivity would be poor.

2. Experiment setup

A schematic diagram of UV absorption spectroscopy is presented. It is consists of VUV monochromator, plasma chamber and hollow cathode. The type of the plasma is ICP and the frequency is 13.56MHz. The helium and oxygen gas flow rate is controlled by independent mass flow controller. The monochromator is connected to the ICP chamber with hollow cathode to obtain VUV emission lines.

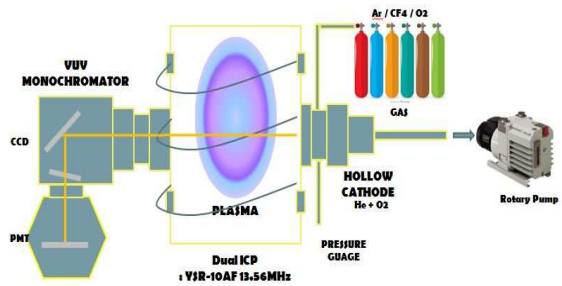

Figure1. Schematic diagram of VUV lamp

3. Result and discussion

We conclude that above currents of mA breaks down and discharge begin to develop from the appearance of the discharges in the hollow cathode and measured current-voltage characteristics. The range of the pressure is showed from 10Torr to 100Torr. The kinds of gas are helium and O2. Spectral measurements have been performed using a 250-900nm Princeton Instruments SCT 320. The difference of the glow mode and hollow mode is the intensity of the wavelength. The 546nm(wavelength) is higher, when the mode is change by hollow mode. The 546nm(wavelength) is helium line. And the wavelength is shifted by gas mixture (helium lonely & helium and O2). In fact we can analyze the condition of plasma by analyzing wavelength. We use boltzmann plot theory for the theoretical verification wavelength. The excitation temperature is very important parameter to analyze the state of plasma. We use NIST atomic spectra database for deduct the excitation temperature in kelvin. The excitation temperature of hollow mode is higher than the excitation temperature of glow mode.