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Plasma Deposition of TiO_2 Thin Film by Introducing Water Vapor
水蒸気導入によるTiO_2薄膜プラズマ堆積

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Deposition of TiO_2 film on a glass substrate was attempted utilizing Ar plasma admired with water vapor. The intensity of Balmer-α line spectrum correlated well with water vapor pressure in the discharge, and can be a measure of oxygen content in the discharge.

1. Introduction

Since Honda and Fujishima reported the photoactivity of titanium oxide (TiO_2) in1972 [1], many articles about the properties and the applications of TiO_2 have been published. Electron-hole pairs are generated by light photo absorption. Because of the pairs, TiO_2 has strong oxidation power. TiO_2 can decompose water into hydrogen and oxygen and reduce organic dirt. For this character, titanium oxide has been used for antibacterial or antifouling. Among three kinds of crystalline phases: rutile, anatase, and brockite, anatase has high photoactivity and it is easy to produce. On the other hand, there are researches about controlling the property of photocatalyst by adding impurity to rutile [2].

Noguchi et al. reported that film quality is affected by introducing water vapor into chamber [3]. As is known that silicon oxide film is formed on silicon wafer by annealing wafer in water vapor, water is known as oxidizer. Therefore, in this paper water is used in place of oxygen gas and the effects due to introducing water vapor into Ar plasma are reported.

2. Experiment

TiO_2 thin films are deposited on the substrate by DC magnetron sputtering. Experimental system is shown in Fig.1. The anode and cathode are facing parallel and the distance between the target on the cathode and the substrate on the anode is about 100 mm. The target is 99.5% pure titanium plate (150 × 200 mm) and the substrate is made of borosilicate glass. Neodymium magnets which are 10 mm diameter and 20 mm height are arranged at the back side of the target. During deposition, Ar gas and H_2O gas are introduced into the chamber and partial pressure of H_2O is 30%. Discharge voltage is about 280 V, and discharge current is 0.15 A. Titanium oxide films are deposited for 6 hours.

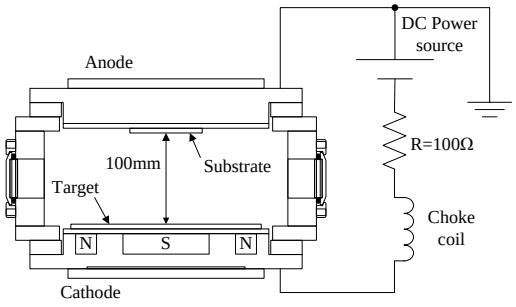

Fig.1. Schematic of experimental system

3. Results

The emission spectrums of Ar and Ar-H_2O mixed gas are shown in Fig.2. As the partial pressure of H_2O increase, the intensity of Balmer series becomes high. Thus, Balmer α and H_2 molecular bands can be a good monitor to estimate H_2O, and the corresponding oxygen contents in the plasma.

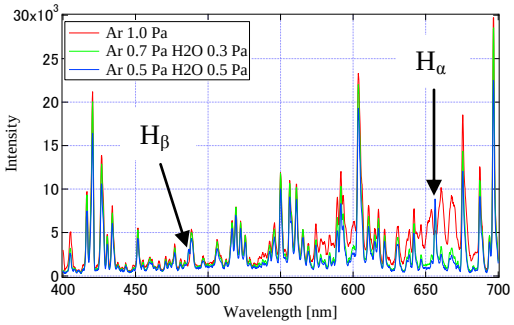

Fig.2. Spectrum of plasma

References

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[3] D. Noguchi, Y. Kawamata and T. Nagatomo: J. Appl. Phys. 42 (2003) 5255-5258.