Magnetron sputtered PdAu alloy thin films for high sensitive hydrogen sensor application

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INTRODUCTION

Hydrogen is the lightest element, the most abundant in the universe and a future clean energy source[1]. Additionally, hydrogen is used in a wide range of industrial applications, including chemical, glass, plastic, food, transportation, and semiconductor industries. On the other hand, hydrogen has a lower explosion limit of 4% in air and it is colorless, odorless, and tasteless and cannot be detected by the human senses. Therefore, accurate and fast hydrogen detection is very important. Hydrogen sensors are used for especially safety issues, real-time quantitative analysis and leak detection during the use of hydrogen in various industrial applications[2,3]. Among the various hydrogen sensors depending on the physico-chemical detection mechanism, the resistive metallic hydrogen sensor is one of the best performing. In general, palladium (Pd), platinum (Pt), and their alloy are used as a sensitive materials for metallic resistive hydrogen sensors[4]. In this study, the structural and resisitive hydrogen sensing properties of PdAu alloy thin films prepared on a glass substrate with various film thickness were investigated.

EXPERIMENTAL STUDY

The PdAu thin films were prepared by using the magnetron sputtering technique from PdAu alloy target (Pd:Au atomic ratio is 20:80) on a microscopic glass substrate. The thicknesses of the films were changed from approximately 3 nm to 10nm and simultaneously measured with a QCM sensor from Inficon in the PVD system. Structural characterization of the film was done by scanning electron microscopy (SEM), Energy Dispersive X-ray spectroscopy (EDX) and X-ray photoelectron spectroscopy (XPS) techniques. Two silver electrodes are coated on the PdAu alloy films by using thermal evaporation system with a shadow mask to obtain resistive sensor devices. The hydrogen sensing properties of PdAu alloy thin films were tested depending on temperature, hydrogen concentration, and the film thickness.

RESULTS AND DISCUSSION

Fig. 1a shows the XRD pattern of the PdAu alloy thin film. The resistance versus time graphs of PdAu alloy thin film with 3nm and 6nm thickness at room temperature for various hydrogen concentration are present in Fig. 1b and 1c. The hydrogen exposure causes a decrease in the resistance for the measured concentration. This behavior is opposite to pure continuous Pd based resistive hydrogen sensor [4-5]. The hydrogen sensing properties PdAu alloy thin film depending on temperature, concentration and film thickness will be discussed in detail.

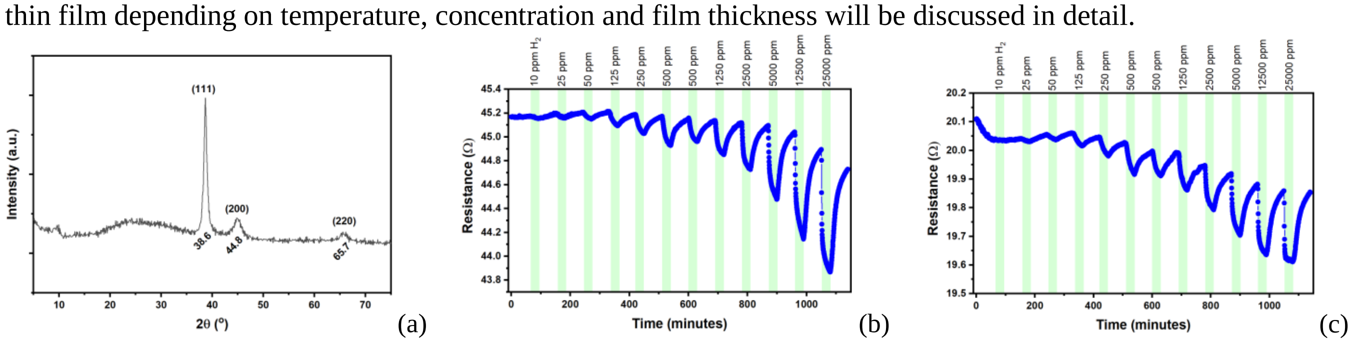

Fig. 1 XRD pattern (a), resistance versus time graphs of the PdAu alloy thin film at RT with a thickness of 3 nm (b) and 6 nm (c)

CONCLUSION

PdAu alloy thin film based resistive hydrogen sensor devices showed high sensitivity at room temperature and could be used in leak detection applications.

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