Response Properties of Tantalum Oxide for Hydrogen Gas Detection

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Abstract

Hydrogen is highly combustible as 4% v/v concentration in air forms an explosive mixture, and also is a major cause of corrosion for steel and other metals, especially at elevated temperature. Therefore, hydrogen gas sensors have been demanded widely in industries, where hydrogen leakage is unavoidable. There are many hydrogen sensors [1-3]. Among them, sensors using metal-oxide film are widely used because of their good sensitivity and reliability. We fabricated an SiC-based hydrogen gas sensor with MIS (metal-insulator-semiconductor) structure, enable to operate at high temperatures, where a thin tantalum oxide (Ta_2O_5) layer was especially investigated with the purpose of sensitivity improvement because tantalum oxide has good stability with high permeability for hydrogen gas. The tantalum oxide layer was formed by oxidizing a tantalum (Ta), sputtered on 1cm^2 SiC substrates for 2min with 300W of power, by rapid thermal processing (RTP) at 500℃ for 3min in an atmosphere containing oxygen. And then Palladium (Pd) was deposited on the tantalum oxide film with a shadow mask to complete Pd/Ta_2O_5/SiC hydrogen gas sensors. The fabricated sensors were examined with an SEM and an X-ray diffraction (XRD) to know crystal structure and uniformity of Ta_2O_5 film, as shown in Figure 1, and 2, respectively. We measured and analyzed both the variation in capacitance and I-V characteristics for different hydrogen concentrations from 0 to 2,000 ppm with a variation in temperature ranging from room temperature to 500 °C. As the result, the I-V curve shifted slightly to the lower voltage and the forward current increased at a fixed voltage when the hydrogen concentration increased. The average value of C/Co was observed to be about 15 percent per 1,000 ppm hydrogen concentration (where Co indicates the value in capacitance at the state of zero hydrogen concentration, and C is the variation in capacitance). Consequently, our hydrogen sensor showed promising performance in respect to the sensitivity and the adaptability at high temperature.

Acknowledgement

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References

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Figures

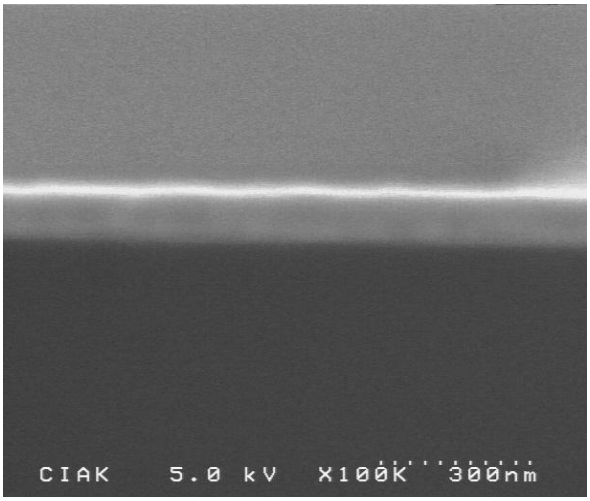

Fig.1. SEM image of the tantalum oxide layer

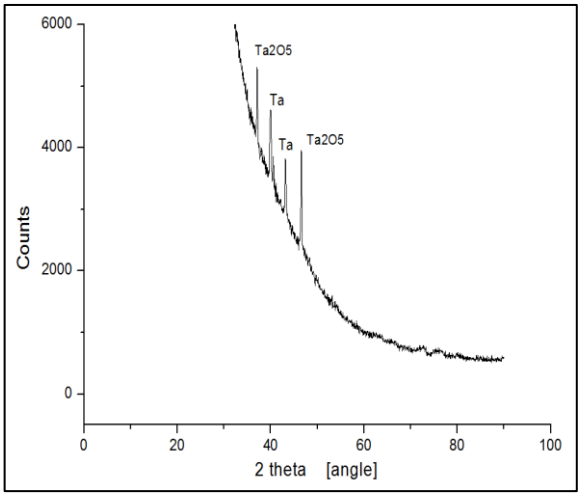

Fig.2. XRD analysis of the tantalum oxide layer