Preparation of functional thin films using powder target
粉体ターゲットを用いた機能性薄膜の作製

Hiroharu Kawasaki, Kento Arafune, Tamiko Ohshima, Yoshihito Yagyu and Yoshiaki Suda
川崎仁晴，荒舩健人，大島多美子，柳生義人，須田義昭

Department of Electrical and Electronic Engineering, Sasebo National College of Technology
1-1 Okishin, Sasebo, Nagasaki 857-1193, Japan
佐世保工業高等専門学校 〒857-1164 長崎県佐世保市沖新町1-1

Thin films preparing by the sputtering method which used the powder material as a target was performed. XRD results suggest that crystalline TiO_2 thin films can be prepared using Ti powder target, and crystallinity of the film depend on the substrate temperature. These experimental results suggest that TiO_2 thin films can be prepared using supttering deposition with Ti powder target and quality of the film was almost same prepared using common bulk target.

1. Introduction

Plasma processing, such as plasma enhanced chemical vapor deposition, sputtering deposition, pulsed laser deposition (PLD), has been used for functional thin film deposition. We have been prepared several kinds of functional thin films using those methods[1-8]. In general, high-density bulk targets have been used to prepare functional thin films by the sputtering method and PLD method. Therefore, burned and hardened bulk targets have been produced before thin films preparation. However, the method cannot be used for material which will deteriorate by heating, and the films with some element ingredients. In addition this method requires cost to prepare high quality films. We also prepared organic electroluminescence (OEL) thin films using PLD method. To increase the target density, the Alq_3 targets was produced using shock solidification technology. However, prepared film does not have enough quality for OEL. These problems can be solved by using powder material for a target as it is.

In this study, film preparing by the sputtering method which used the powder material as a target is performed. The growth mechanism is investigated in the probe method, a spectroscopic method, and X- ray analysis.

2. Experimental

RF magnetron sputtering system with powder target was used to prepare thin film in this experiment, as shown in Fig. 1. Powder titanium material (99.9%, 45μmϕ) and bulk Ti target (99.98%) was used as targets. The chamber was evacuated to 5×10^{-5} Pa, and then Ar and O_2 mixture gas were fed into them to 10 Pa. Sputtering plasmas were generated by RF voltage of 13.56MHz. RF power increased 20W to 100W at 1W/min, and after that films were prepared for 120 minutes. The crystalline structure and crystallographic orientation of the prepared thin films were characterized by X-ray diffraction analysis (XRD; RIGAKU RINT2100V) using CuKα radiation. The surface morphology of the films on Si(100) substrates was observed by atomic force microscopy (AFM; JOEL JSPM4210).

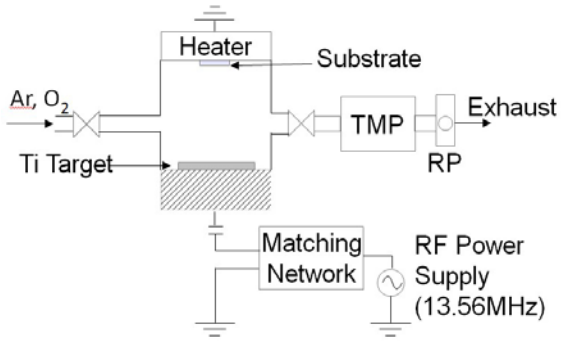

Fig.1. Experimental Setup

3. Results

Fig. 2 shows XRD patterns of the films prepared by RF magnetron sputtering with Ti powder target as parameters of Ar:O_2 gas mixture. It is suggest that XRD pattern of the films almost same independent for the Ar gas mixture. A crystalline of rutile TiO_2(110) and TiO(200) peaks can be observed. The results suggest that polycrystal TiO_2 thin films can be prepard using the method. Fig. 3 shows XRD patterns of the film prepared using bulk target. The results suggest that a crystalline of TiO(200) peaks can be observed independent for the Ar gas mixture. Fig. 4 shows XRD patterns of the films prepared by RF magnetron sputtering with Ti powder target as parameters of substrate

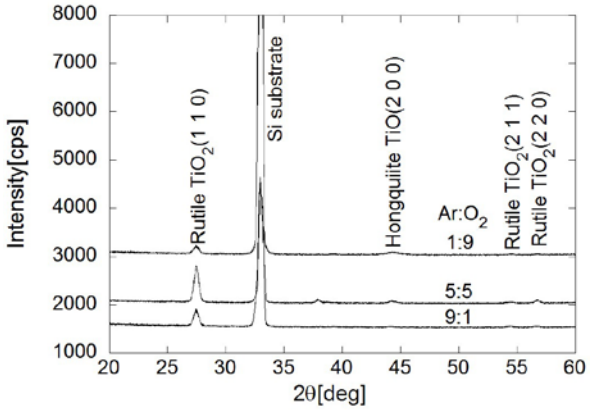

Fig.2. XRD patterns of the films prepared usnig Ti powder target as parameters of $Ar:O_2$ gas mixture.

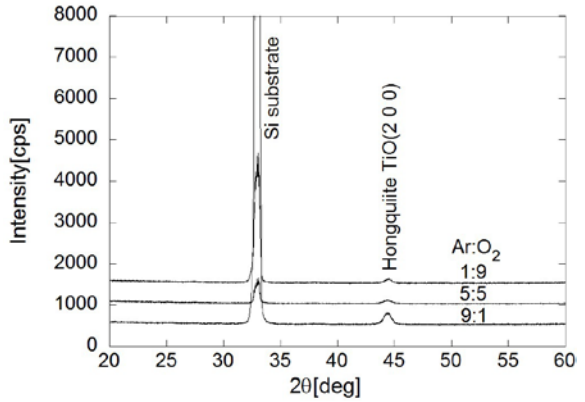

Fig.3. XRD patterns of the films prepared usnig Ti bulk target as parameters of $Ar:O_2$ gas mixture.

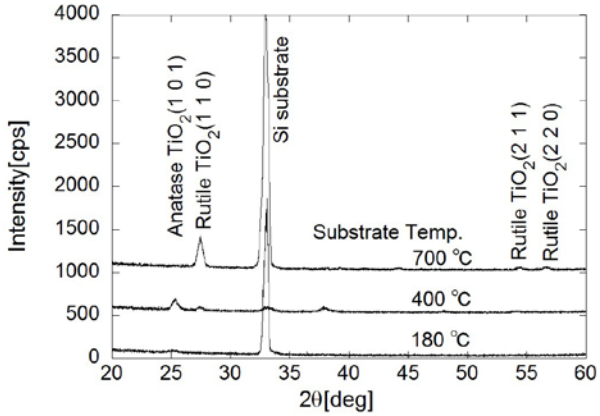

Fig.4. XRD patterns of the films prepared usnig Ti powder target as parameters of substrate temperature.

temperature. At the low substarte temperature anatase TiO_2(101) can be observed. However, rutile TiO_2(101) can be observed at the high substrate temperature.

We also observed surface morphology of the films by AFM. Both of the AFM images of the film using bulk and powder shows very smooth and mean roughness is ~nm. The films were found to be composed of small particles of 30~50 nm in diameter.

These experimental results suggest that TiO_2 thin films can be prepared using supttering deposition with powder target and quality of the film was almost same prepared using bulk target.

5. Conclusions

RF magnetron sputtering system with powder target was used to prepare thin film. XRD results suggest that crystalline TiO_2 thin films can be prepared using Ti powder target, and crystallinity of the film depend on the substrate temperature.

Acknowledgments

This work was supported in part by a Grant-in-Aid for Scientific Research in Priority Areas (B) (No.23340181), Grant-in-Aid for Scientific Research on Innovative Areas (No.22110519), Nippon Sheet Glass Foundation for Materials Science and Engineering.

References

[1] H. Kawasaki, K. Doi, S. Hiraishi, and Y. Suda: Jpn. J. Appl. Phys. **39** (2000) 4525.

[2] Y. Suda, H. Kawasaki, C. R. Cho, A. Grishin, and K. V. Rao: Jpn. J. Appl. Phys. **39** (2000) 4575.

[3] Y. Suda, H. Kawasaki, K. Doi, J. Namba, T. Ohshima, T. Nakazono, and T. Ohshima: IEEE Trans. **IIT2000** (2001) 785.

[4] Y. Suda, K. Doi, J. Namba, F. Imura, and H. Kawasaki: Jpn. J. Appl. Phys. **40** (2001) 1061.

[5] Y. Suda, H. Kawasaki, K. Doi, J. Namba, and T. Ohshima: Mater. Charact. **48** (2002) 221.

[6] H. Kawasaki, T. Ohshima, Y. Yagyu, Y. Suda, S. I. Khartsev, and A. M. Grishin: J. Phys. : Conf. Ser. **100** (2008) 012038.

[7] D. Dzibrou, A. M. Grishin, and H. Kawasaki: Thin Solid Films **516** (2008) 8697.

[8] H. Kawasaki, T. Ohshima, Y. Yagyu, and Y. Suda: Trans. Mater. Res. Soc. Jpn, **33** (2008) 655.