7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

Deposition of transparent conducting oxide thin films using pressed powder targets

Magdaleno R. Vasquez Jr.[1], Rozen Grace B. Madera[1], and Tomohiro Yamaguchi[2]
[1]Department of Mining, Metallurgical, and Materials Engineering, College of Engineering, University of the Philippines Diliman
[2]Department of Applied Physics, School of Advanced Engineering, Kogakuin University
e-mail (speaker): mrvasquez2@up.edu.ph

Transparent conducting oxides (TCOs) have attracted a lot of potential applications due to its high transparency and conductivity. At present, these TCOs are widely used as electrodes in flat panel displays and photovoltaic (PV) cells [1]. The industry use tin-doped indium TCOs due to their low resistivity (<10^{-3} Ω-cm) and high transmittance in the visible region (> 80%) [2]. However, indium is a scarce resource which drives the cost of the TCOs and limits its widespread application. Hence, alternative TCO materials are constantly being explored. In this work, we present the growth of TCO films on silicon and glass substrates using a custom-built deposition system with a magnetron configuration. The sputtering system is operated at subatmospheric pressures powered by a 13.56 MHz radio frequency (RF) power source using argon as the working gas. To deposit the films, targets were custom-made from powder precursors. Powders of zinc oxide (ZnO) and alumina (Al_2O_3) with predetermined mass ratios were mixed, pressed, and sintered. The target was mounted on the magnetron gun and aluminum doped ZnO (AZO) films were grown on glass substrates using 50 W incident RF power and around 9 Pa working pressure. X-ray diffractograms reveal the growth of AZO films at different deposition times as shown in Figure 1. Scanning electron microscopy images revealed uniformly distributed grains that are dense and void-free as shown in Figure 2 while cross-section images showed a columnar structure. Energy dispersive X-ray spectrometry revealed less than 1at% Al doping of ZnO. The films also exhibit high transparency in the visible region with low sheet resistance leading to high figures of merit. This work demonstrated the feasibility of preparing targets using powder precursors with a tunable composition that can be used to grow TCOs in subatmospheric conditions.

The authors acknowledge the DOST Accelerated Science and Technology Human Resource Development Program (ASTHRDP) and the Continuous Operational and Outcomes-based Partnership for Excellence in Research and Academic Training Enhancement (COOPERATE) grant of the University of the Philippines.

References

[1] U. Betz, M. Olsson, J. Marthy, M. Escol and F. Atamny, Surf. Coat. Technol, 200(20-21), 5751-5759 (2006).
[2] S. Rozati, and S. Ziabari, Mater. Chem. Phys., 126789 (2022).

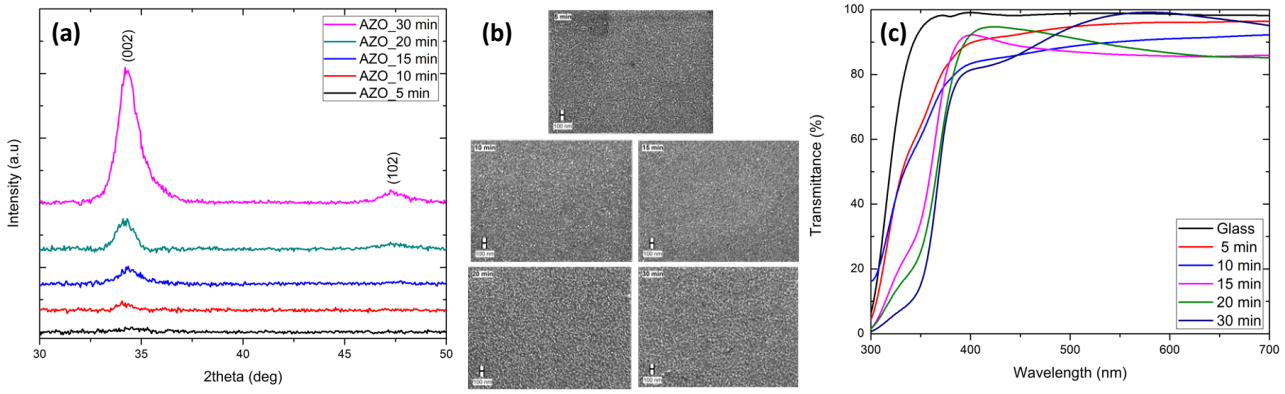

Figure 1.(a) X-ray diffractograms, (b) SEM images, and (c) transmittance spectra of the deposited AZO films.