Aluminium doped ZnO thin films

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Abstract

Recently, ZnO thin films have attracted significant attention of researchers due to their complex of unique properties, such as a wide bandgap of 3.37 eV, good transparency in the visible range, high exciton binding energy (60 meV), cost effectiveness, and environmental safety. Thanks to this, this material can be used in various industries, such as thin film transistors, gas sensors, white light-emitting diodes, solar cells, and as piezoelectric semiconductors.

Sample preparation

The ZnO thin films were deposited by radiofrequency magnetron sputtering using a high-purity target made of pressed ZnO powder (99.9%) with a diameter of 4.0 cm (12.57 cm^2). The aluminum modification was carried out by placing different numbers of aluminum plates with an area of 0.25 cm^2 on the ZnO target, in particular, 2, 4, and 9 plates for Al05, Al10, and Al25 samples, respectively. All the resulting films were deposited within 60 minutes.

Results

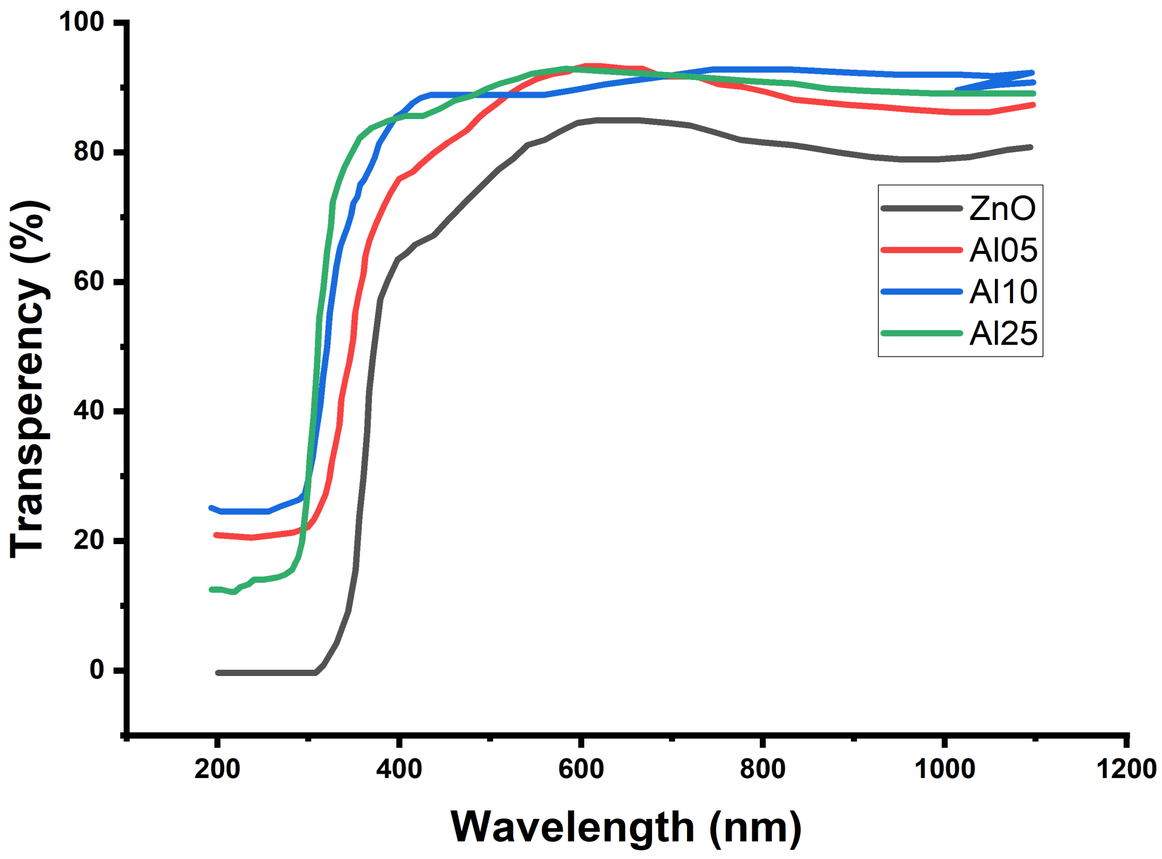

Figure 1. Transmission spectra of ZnO thin films.

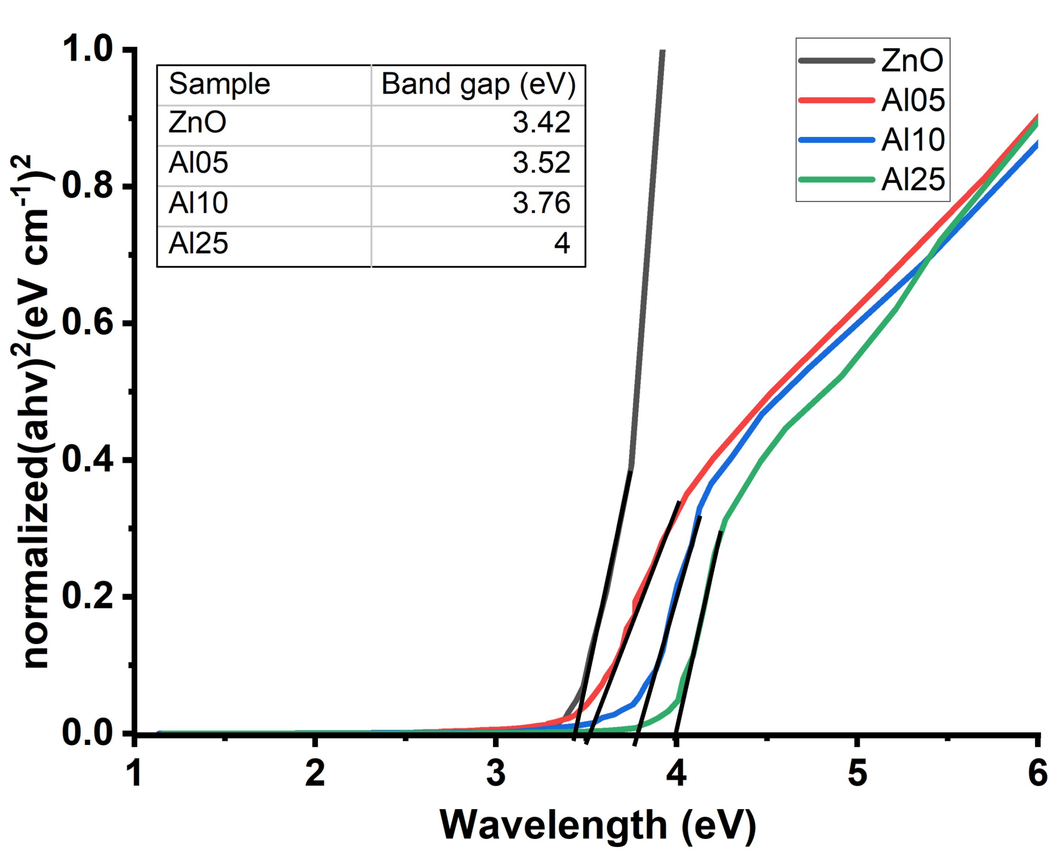

Figure 2. Tauc plot for determining band gap.

After modification of ZnO thin films with aluminum, an increase in the transparency of the films is observed(Figure 1). All films are characterized by good transparency in the entire visible range, as well as in the near-infrared spectrum. Absorption near 370 nm is associated with the absorption edge. The Tauc[1] method(Figure 2) was used to determine the band gap, which increases with increasing aluminum concentration.

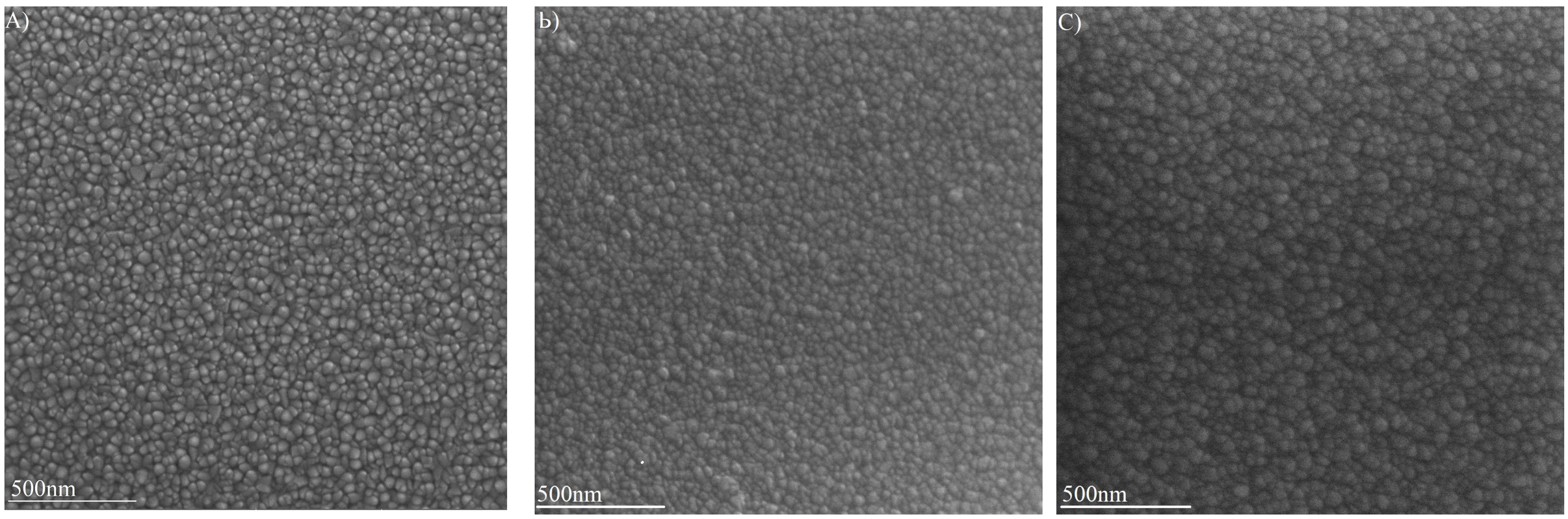

Figure 2. SEM images of nanostructured thin films. a) ZnO b)Al05 c) Al10.

After aluminum is added, a change in grain size is observed. Thus, if we compare the ZnO and Al05 samples, we can notice an increase in the size of some grains, but the average grain size decreases due to the appearance of a large number of small grains. With the further addition of aluminum, there is an undeniable increase in grain size for the Al10 sample.

Conclusion

The nanostructured thin films of ZnO modified with aluminum were successfully obtained by radio frequency magnetron deposition. With an increase in the number of aluminum plates in the synthesis, an increase in transparency and the value of the band gap is observed.. Also, after adding aluminum, the grain size on the film surface changes.

[1] J. Tauc, Mater. Res. Bull, **3**, No.1: 37–46(1968).