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Aluminum doped ZnO thin films deposited by r.f. magnetron sputtering at low frequency and room temperature

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Abstract Aluminum doped zinc oxide (ZnO:Al) transparent conducting thin film with different thickness were prepared by r.f. magnetron sputtering using ceramic target onto glasses substrates. Surface morphology and electric charge distribution investigated by atomic force microscopy (AFM) have shown a strong influence of deposition parameters on the surface morphology. Surface potential variations were also observed by scanning probe microscopy and correlated to measurements of conductivity and transmittance.

Transparent conducting aluminum doped zinc oxide (ZnO:Al) films have been extensively studied in recent years because they exhibit high optical transmission and electric conduction and have a lower material cost. These films have an extensively applications as electrode in solar cell and a number of other optoelectronics devices [1-2]. In this work, ZnO:Al were deposited on glass substrate by r.f. magnetron sputtering, using a ZnO target (diameter 7.62 cm) with small aluminum plates disposed in its surface. All deposition procedures were started after the chamber reaches a pressure of 8.2×10^{-4} Pa. Films were deposited at room temperature using the following parameters: Ar gas flow of 16.9 sccm; r.f. power was varied from 1.10 W/cm^2 to 6.58 W/cm^2; pressure was varied from 0.3 Pa to 8.0 Pa and 5 cm of separation between the target and substrate. The dependence of the electrical and optical properties of ZnO:Al thin films as function of the r.f. power density is shown in Tab. 1. The lowest electrical resistivity was obtained for films deposited using 6.58 W/cm^2. All films present an overall transmittance in the visible spectra of about 80%. Standard non-contact AFM image topography shown in Fig. 1(a) reveal films with microcrystalline structure. SEPM image shown in Fig. 1(b) reveal a lateral surface contact potential variations and its own bright regions indicate regions of the sample with higher potential gradient. It is particularly suggestive of array formed by aluminum atoms segregated to grain boundaries.

Table 1: Electric and optical properties of the ZnO:Al films deposited at 8.0 Pa during 8.0 minutes as a function of r.f. power density.

RF power density (W/cm^2)	Deposition rate (Å/min)	Resistivity (Ωcm)	T(%) (400-800nm)
2.19	297.50	2.17	80
4.38	570.01	0.97	85
6.58	1373.70	0.096	83

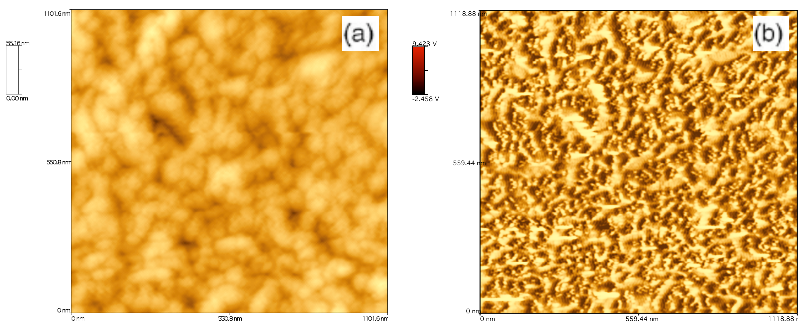

Figure 1: Images of ZnO:Al thin film with:Al r.f. power density of 6.58 deposited at 8.0 Pa during 8.0 minutes. (a) AFM image topography, (b) SEPM image.

References

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