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PHOTOINDUCED WETTABILITY OF PURE AND Al-DOPED ZnO THIN FILMS

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INTRODUCTION

Zinc Oxide (ZnO) nanostructures have attracted intensive research effort for its unique properties and versatile applications in transparent electronics, ultraviolet (UV) light emitters, piezoelectric devices, chemical sensors and photocatalysis. Associated to the photocatalytic activity, ZnO presents also a photoinduced wettability phenomenon, which means that it is possible to change the surface state of the semiconductor from hydrophobic to hydrophilic when this surface is illuminated with UV light [1,2].

In this work we investigated the wettability behavior of films based on ZnO before and after ultraviolet irradiation treatment.

EXPERIMENTAL

1. Thin Films growth

ZnO as well as Al-doped ZnO films were grown on glass substrates using the spray pyrolysis technique [3]. Zinc acetate was used as zinc precursor and different amounts of $AlCl_3$ were added as aluminium source to obtain precursor solutions with 0, 5, 10, 15 and 25 at% of aluminium. The aluminium doping was performed using a mixed solution in one step deposition at 400 °C.

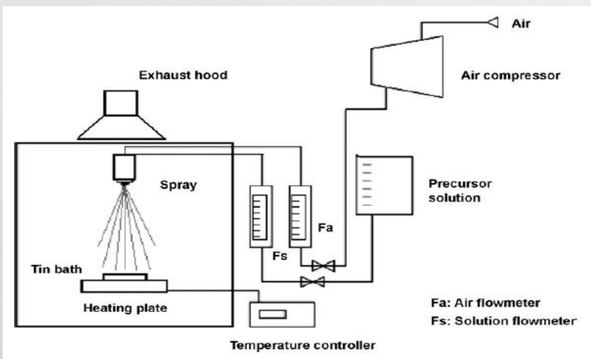


Fig.1 Diagram of the pneumatic spray pyrolysis deposition system

Table 1. Characteristics of the samples

Sample	Al%	Initial CA	Final CA
VAL1	0	101.2 °	12.75 °
VAL2	5	96.25 °	10.9 °
VAL3	10	92.05 °	10.5 °
VAL4	15	97.5 °	11.22 °
VAL5	25	99.5 °	13.9 °

Fig. 2 Static water contact angles on all surfaces were measured using an OCA 200 contact angle goniometer (Dataphysics Instruments GmbH, Filderstadt, Germany) using the sessile drop technique. Droplets of 1.5 µL of nanopure water at room temperature (20 - 23 °C) in air were used.

2. Contact Angle (CA) procedure

1. Samples have been stored in the dark until the precise moment of measurement.
2. Water contact angle has been measured without exposure to a strong light source.
3. Samples have been exposed to a UV light source for 30 minutes.
4. Contact angle measure have been measured again.

RESULTS AND DISCUSSION

SEM

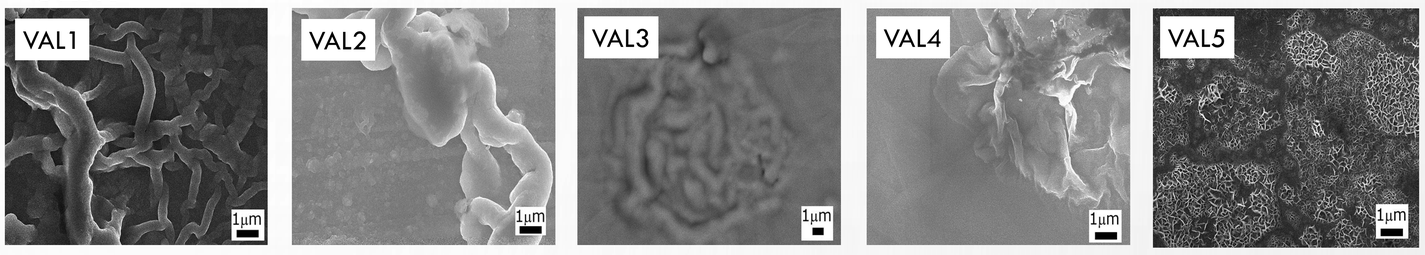


Fig. 3 The surface morphology of the films was analyzed by SEM. The addition of Al to the ZnO modified the surface.

Contact Angle

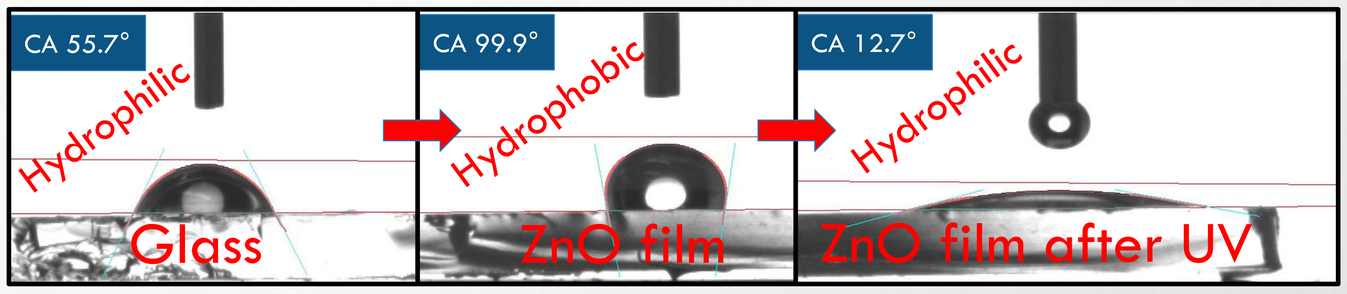
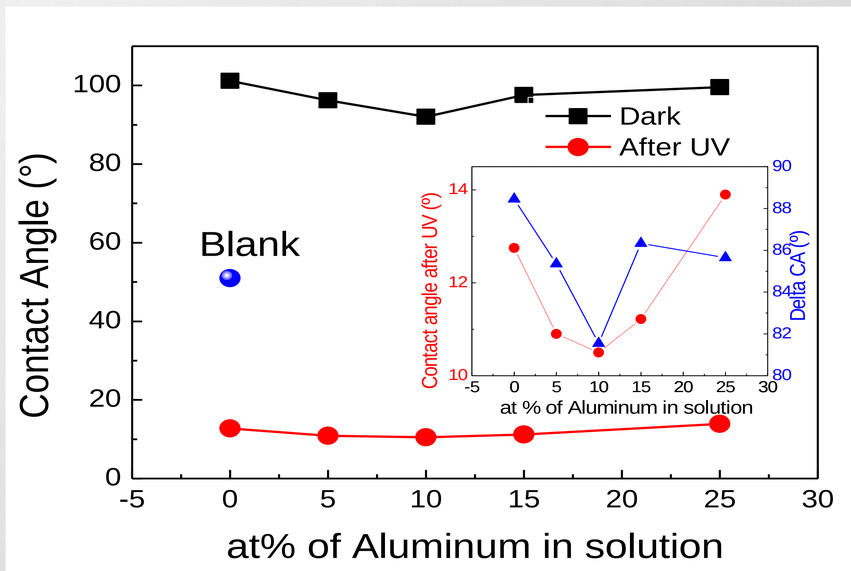


Fig. 4. Image of water droplets used to determine the change in water contact angle on ZnO thin film growth on glass substrate subjected to UV light irradiation for 30 min.

Fig. 4 shows the CA of the films before and after 30 min of UV illumination. It can be observed an optimum value of Al doping (10% Al) where the wettability is the largest. For the highest Al concentration the CA increases again. This could be due to the increase in the nanostructure of the film, needing more time to change its state from hydrophobic to hydrophilic.



As reported in literature [4], the wettability of a surface can be tuned by the surface roughness. The air trapped between the solid surface and the water droplet can change the contact angle. Increasing the air trapped the CA increases. UV light modifies the film's surface, it decreases the air trapped, increasing the surface wettability. Also semiconductor nature of ZnO and its surface chemistry are involved in the transition from hydrophobic to super hydrophilic behavior of the film [5].

CONCLUSION

ZnO films prepared by spray pyrolysis presented photoinduced wettability when exposed to UV light during 30 minutes.

The wettability effect is increased with 10% Al doping of the ZnO films. This Al concentration provided a surface morphology that allowed a larger CA change than the highest Al concentration, which presented more nanostructured surface.

References:

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