Poster Presentation

# A Microstructural Investigation of Al-doped ZnO Films Prepared by Spray Pyrolysis

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During the past few decades, there has been a great demand for transparent conducting oxide (TCO) films, especially from the electronic industry. Compared with tin oxide ($SnO_2$) used in dye-sensitized solar cells and indium tin oxide (ITO) used in polymer solar cells, zinc oxide (ZnO) is used in amorphous and microcrystalline silicon solar cells due to its stability in hydrogen plasma which is the process environment used for such application [1].

In this study, ZnO films were prepared by the spray pyrolysis method, using 0.05M solution of zinc acetate dihydrate in methanol as the precursor [2]. Aluminum-doped series were produced by adding $AlCl_3$ at 0.1, 0.3, 0.5, 0.7 and 1.0 % (atomic) into the precursor solution, respectively. Spray pyrolysis was then carried out for 1 hour to obtain each film, after which the substrate was allowed to cool to room temperature before further analysis. The crystal structures of the ZnO films were studied with X-ray diffraction (Rigaku TTRAX III x-ray diffractometer. The microstructures were examined using FE-SEM, TEM, and high-resolution TEM.

It was found that all films exhibit a preferred crystallographic orientation. The average crystallite sizes calculated from X-ray diffraction data range from 19 to 22 nm, while dark-field TEM images exhibit individual crystallites ranging from 10 to 100 nm in size, approximately. Scanning electron micrographs, Figure 1, reveal porous film structures comprising petal-shaped grains, most of which are significantly larger than the calculated crystallite sizes, indicating that such grains comprise multiple crystallites. Any effects of Al doping concentration on the crystal structure or the microstructure of the ZnO films were not apparent from our current results, however.

## References

1. Major S, Kumar S, Bhatnagar M and Chopra K L. Effect of hydrogen plasma treatment on transparent conducting oxides. *Appl. Phys. Lett.* 1986, 49: 394-396.
2. Lokhande B J, Patil P S, Uplane M D. Studies on structural, optical and electrical properties of boron doped zinc oxide films prepared by spray pyrolysis technique. *Physica B* 2001, 302-303: 59-63.

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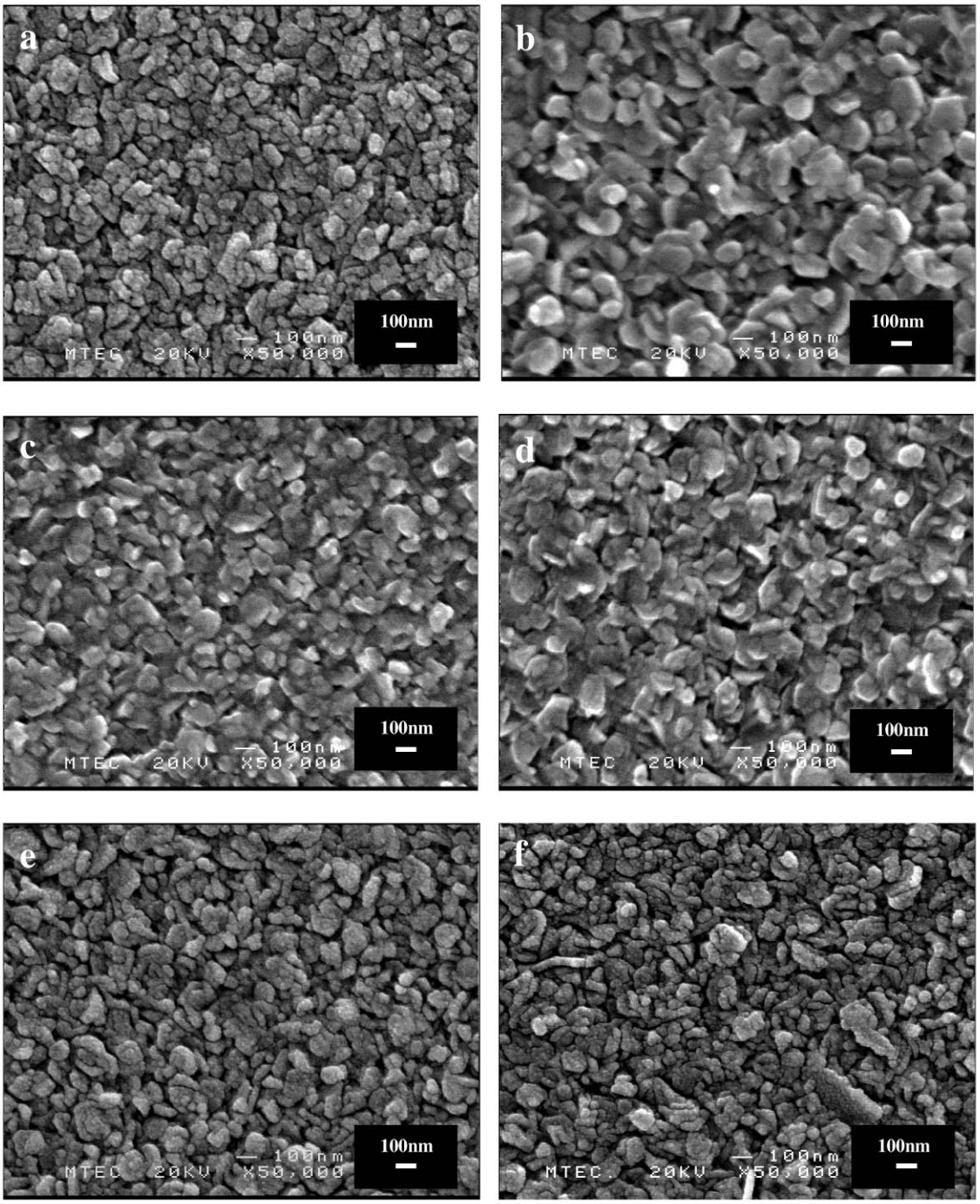


**Figure 1** (a), (b), (c), (d), (e) and (f): Plan-view scanning electron micrographs of the undoped, 0.1%, 0.3%, 0.5%, 0.7% and 1.0% Al-doped ZnO films, respectively.