EFFECTS OF ANNEALING AND POLY - ETHYLENE GLYCOL ON THE PROPERTIES OF ZINC OXIDE THIN FILMS

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Introduction

Zinc oxide (ZnO) is an n-type inorganic semiconductor, which is known as a II-VI semiconductor compound with a direct wide band gap ranging from 3.0 to 3.4 eV at room temperature (Al-Hardan *et al*., 2014).

Its exciting properties:

a)high optical transparency in the visible region (b)relatively abundant

c)low cost of synthesis,

d)non-toxicity

e)Relatively large exciton binding energy & high charge mobility (~60 meV)(Ismail *et al*., 2001 & Mimouni, *et al*., 2015)

Thin film preparation techniques

- spray pyrolysis process
- chemical vapor deposition
- Sputtering and
- sol-gel method

Among these techniques sol gel method- simple and low cost film preparation technique; (2) large area substrates coating; (3) easy composition control; and, (4) thin films can be readily prepared under non-vacuum environment by spin cast or dip coating route, (5) low processing temperatures

Methodology

Materials

- **Zinc Oxide Nanoparticle(ZnO NP)**
- **Polyetylene glycol (PEG)**
- **Chloroform(CHCI3)**
- **Methane (CH4)**

8g ZnO NP (1 ml of CHCI3 & CH4 4:1) Bouclé *et al.*, (2010).

+

0.08g PEG in 1 ml CHCI3

ZnO: PEG sol (10 : 2) ml

Spin cast at 2000 rpm, 1 min.

As-prepared ZnO sample

post annealed at 550 ^{o}C
Annealed sample

Spin cast at 2000 rpm for 1 min

PEG modified sample

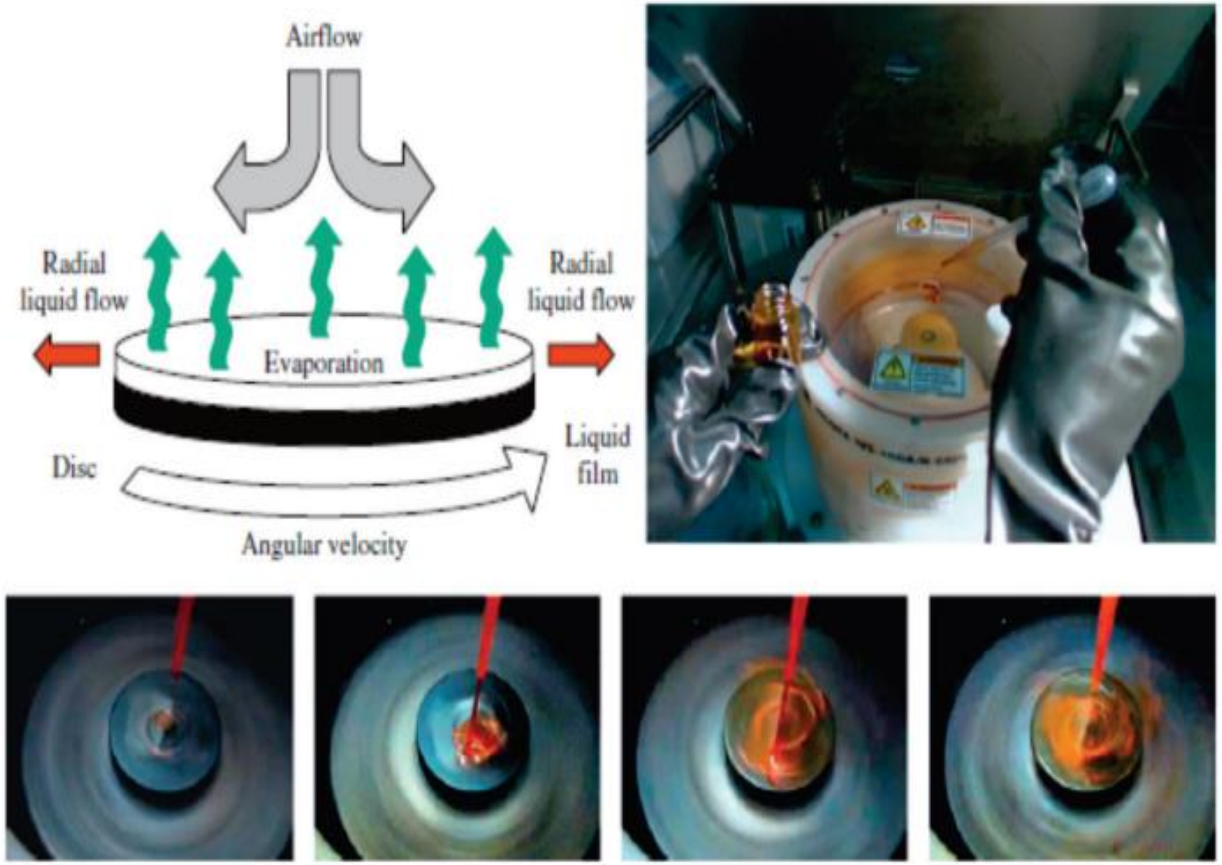

Figure 1: Spin coating deposition techniques. Courtesy of Krebs, 2009

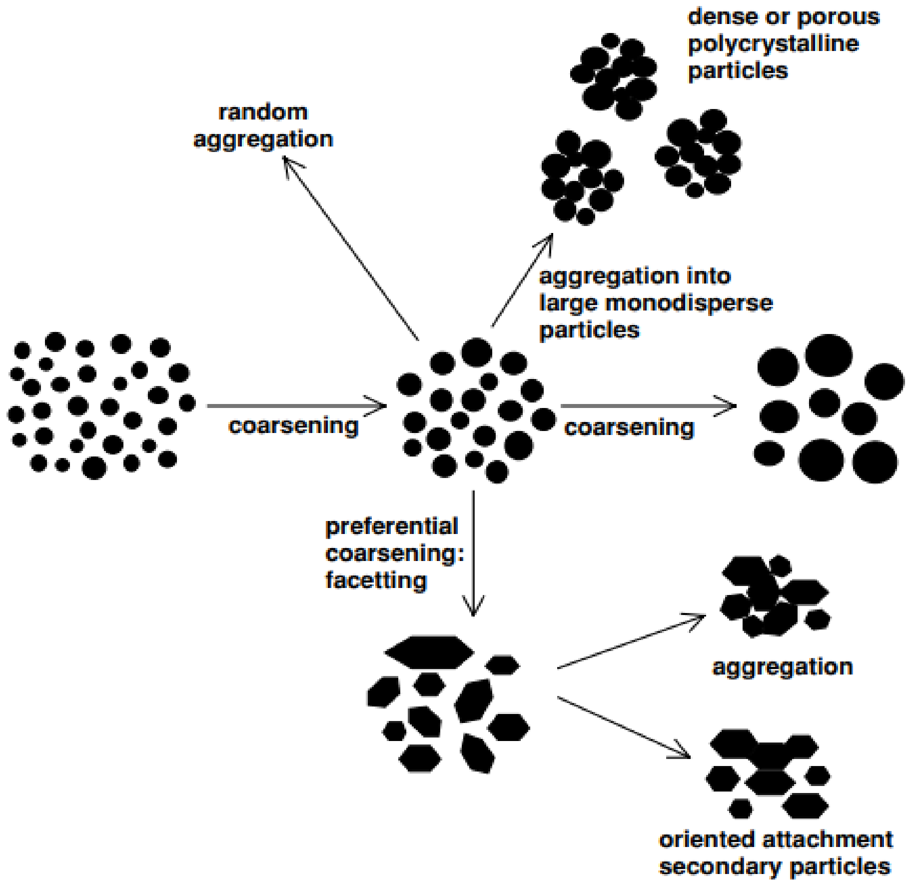

Figure 2: Schematic illustration of growth mechanism in Zinc Oxide colloid synthesis: changes in the physical properties of nanostructure ; average particle size, particle morphology, and aggregation processes. Courtesy of Gerko Oskam 2006

Structural properties of ZnO Thin Films

Indexed to hexagonal ZnO (JCPDS card no. 79-0208).

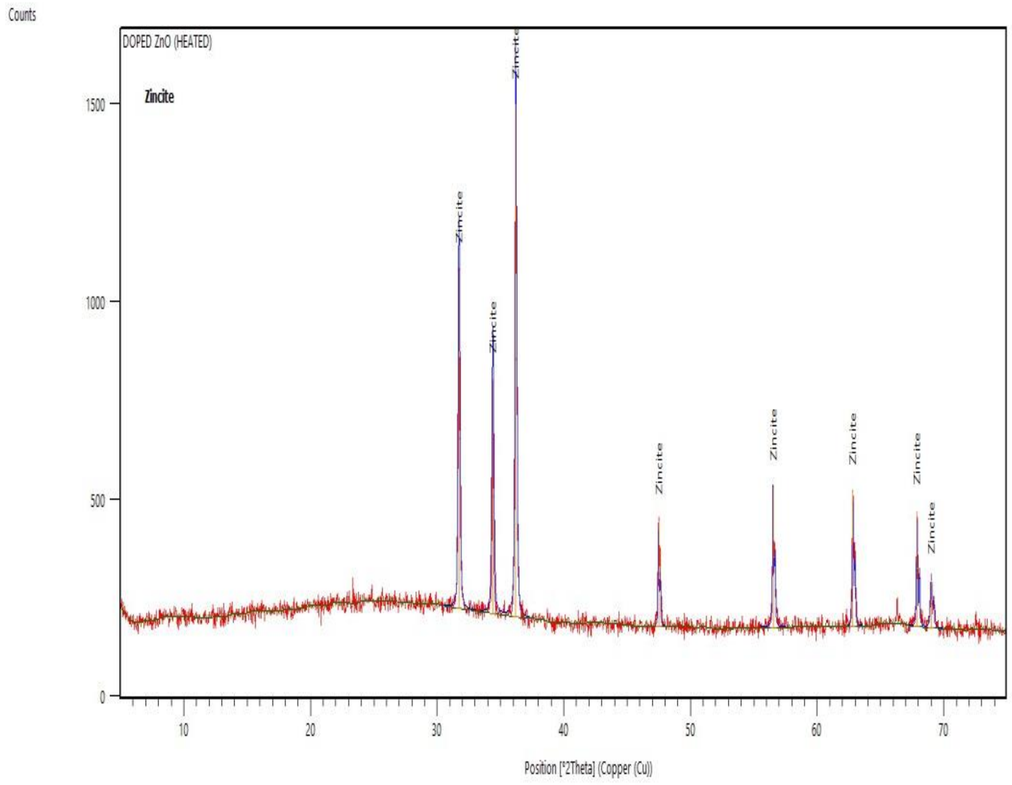

Figure 3: XRD pattern of annealed ZnO thin film

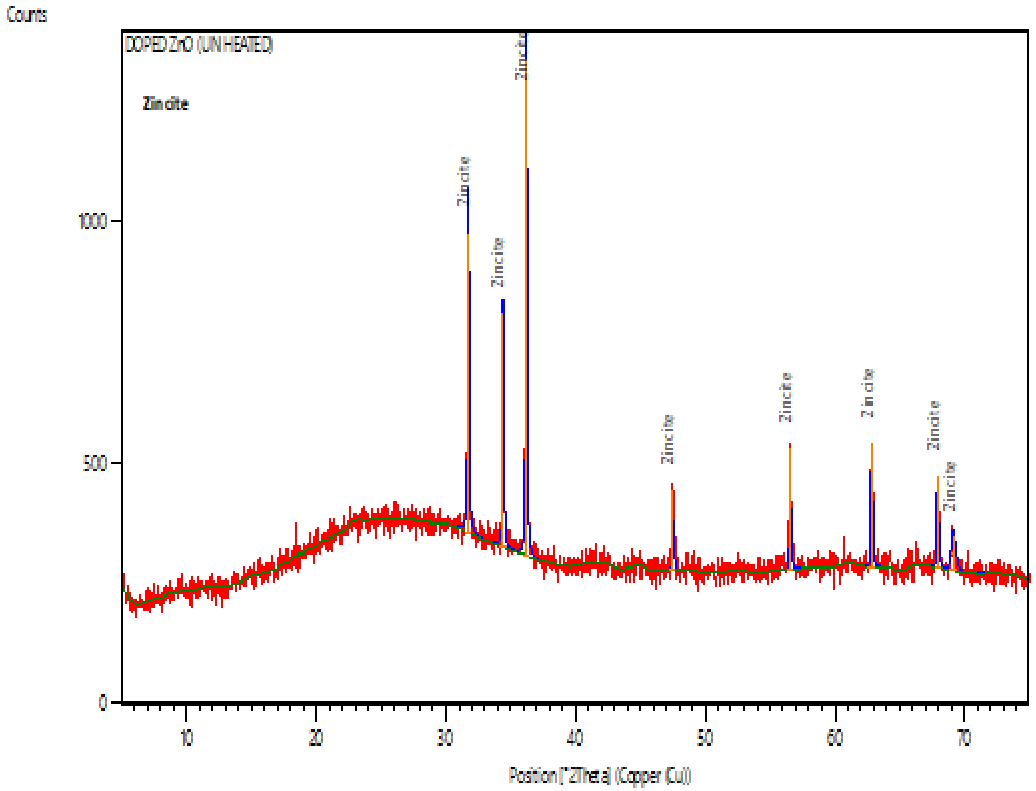

Figure 4: XRD pattern of PEG treated Zinc Oxide (ZnO) thin film.

Results and Discussion

Optical Characterisation of ZnO films

Optical Transmittance

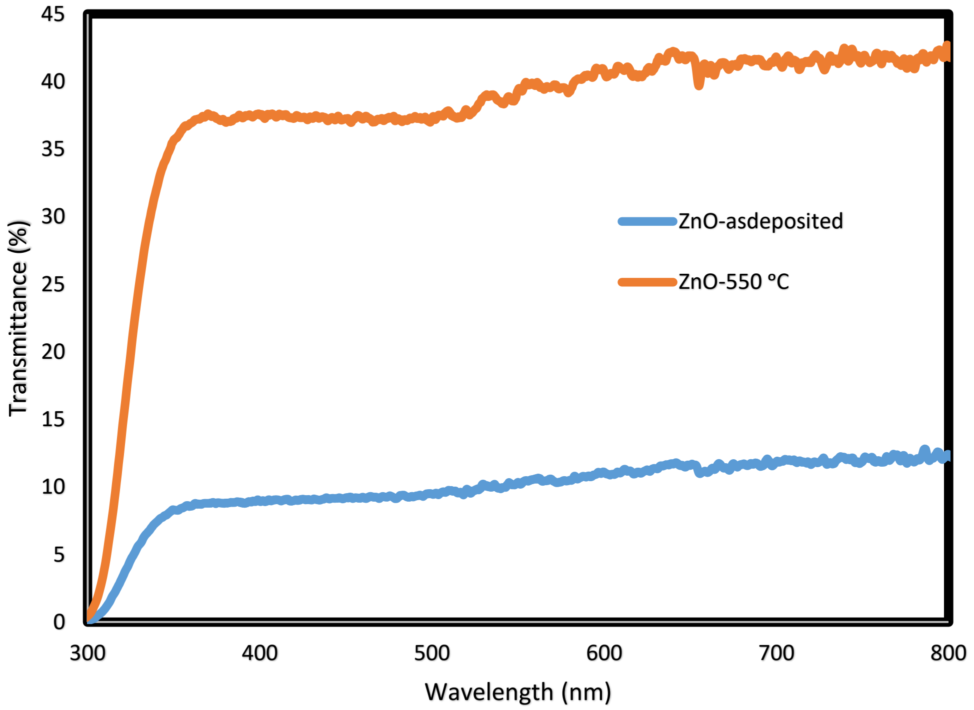

FIGURE 5: Transmission spectra of annealed (550 ^{o}C) and as-deposited ZnO thin films

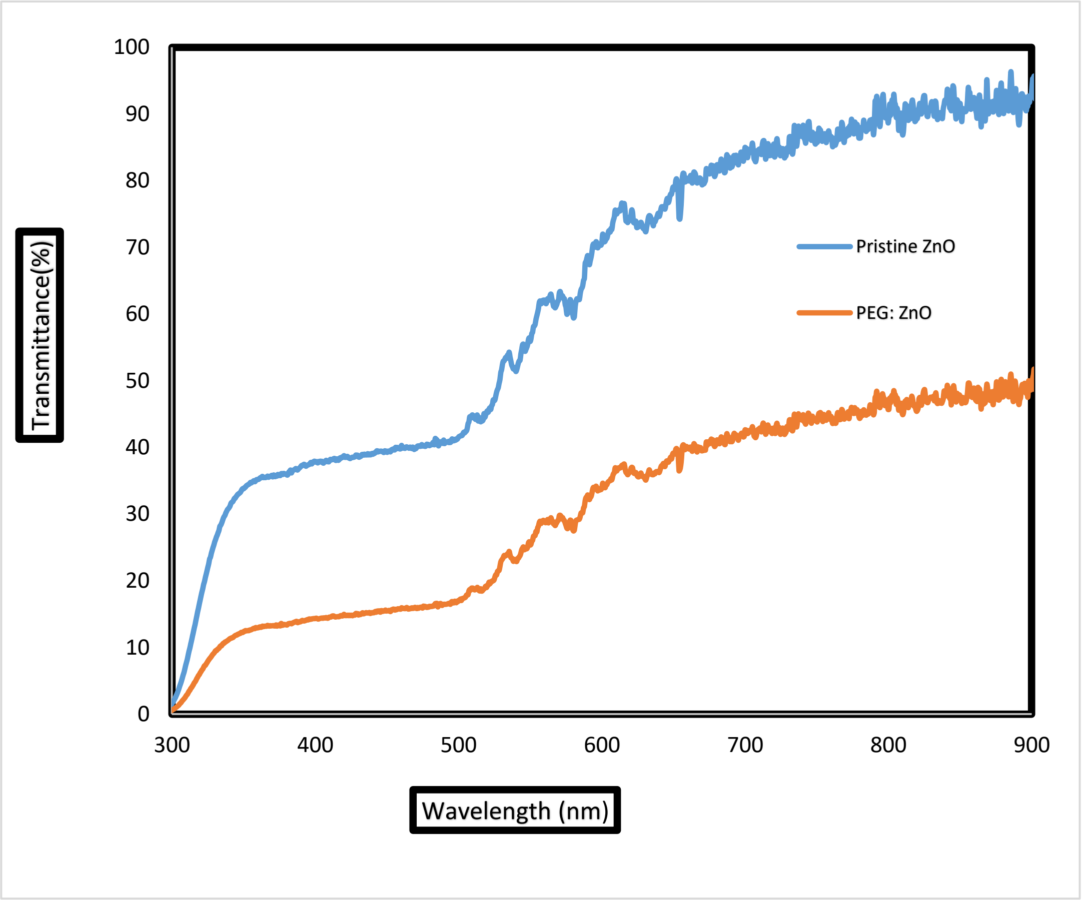

FIGURE 6: Transmission spectra of PEG modified and pristine ZnO thin films

Absorption properties of ZnO films

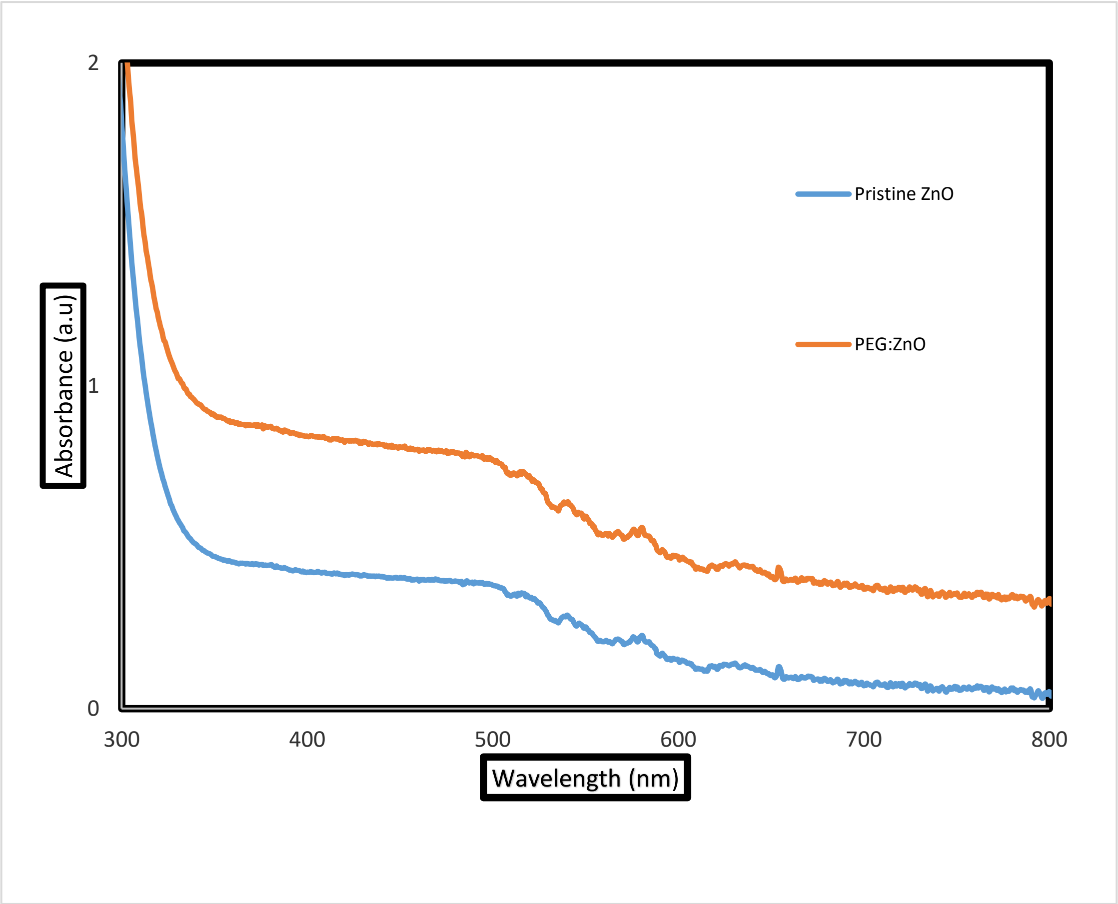

FIGURE 7: Absorption spectra of PEG modified and pristine ZnO thin films

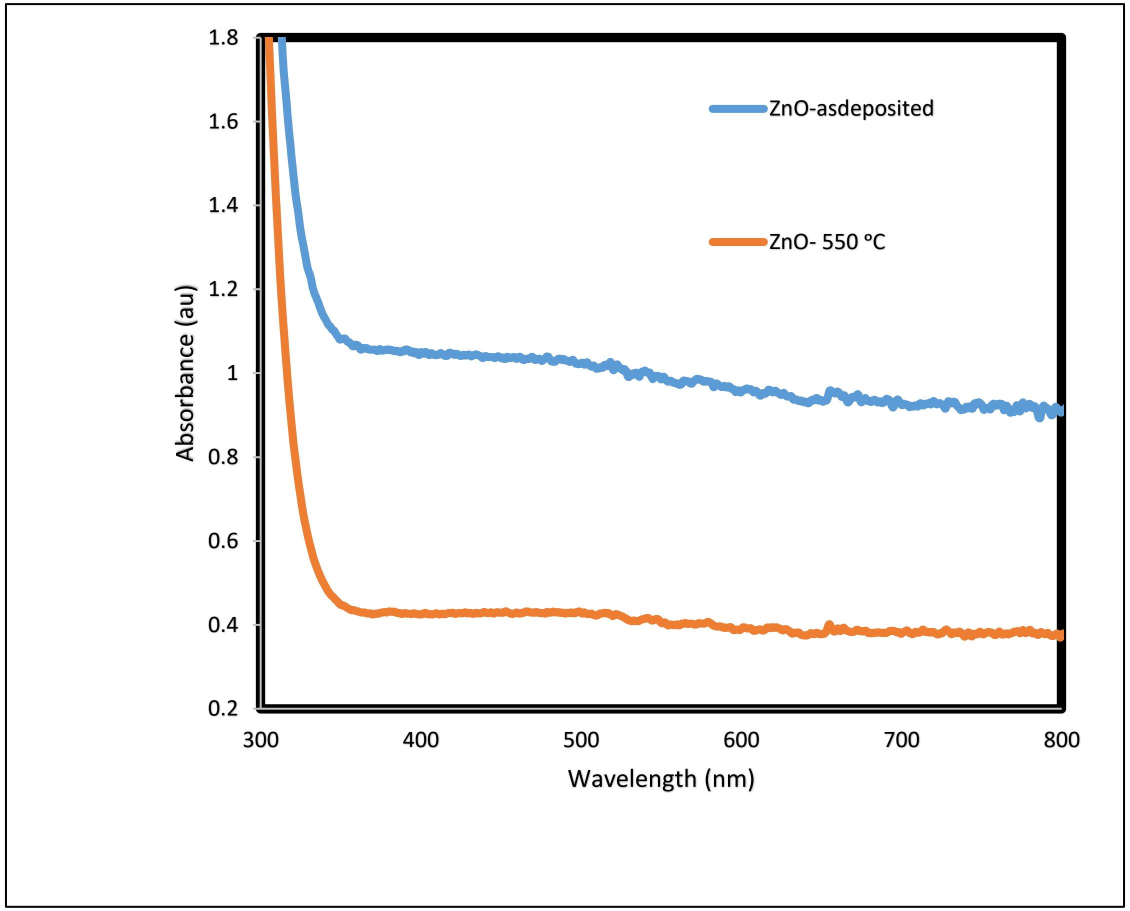

FIGURE 8: Absorption spectra of annealed and as-deposited ZnO thin films.

Optical bandgap of the samples- annealed (3.8 / 3.4 eV) and PEG modified ZnO thin films(3.4 / 3.7 eV)

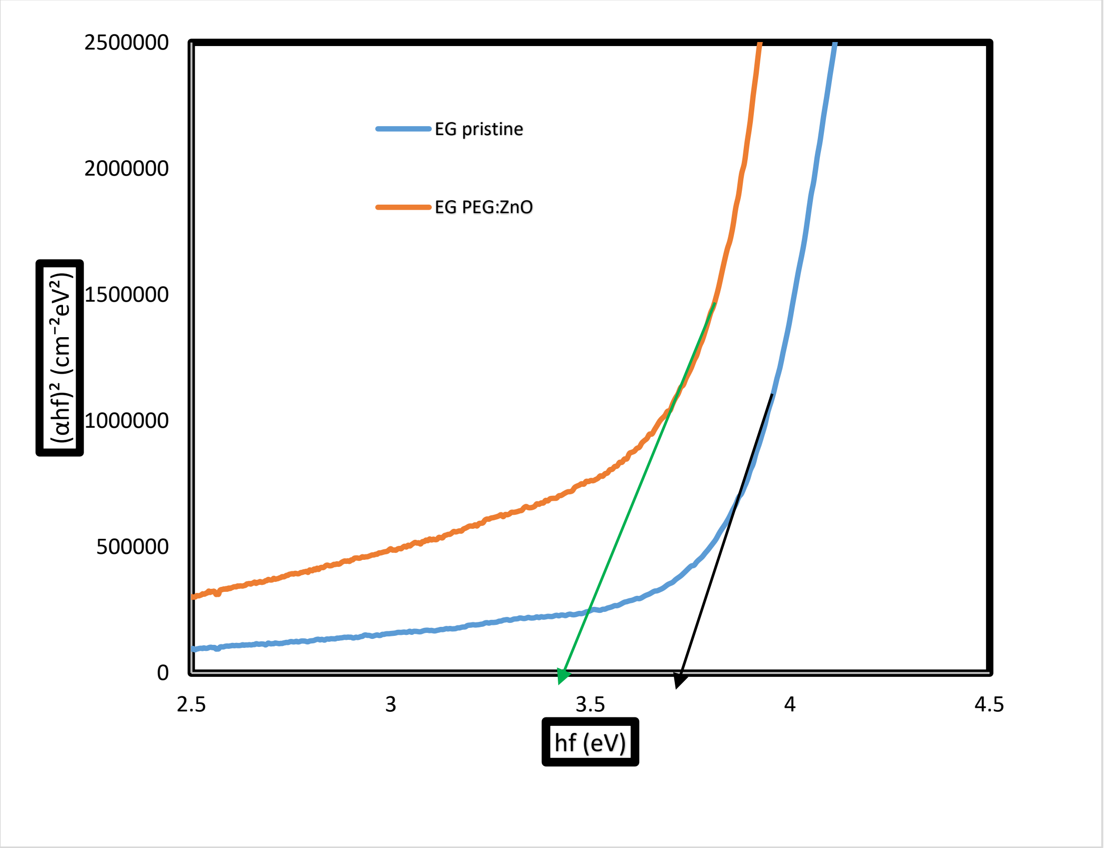

FIGURE 9: The plot of $(\alpha hf)^2$ against energy photon (hf) for PEG modified and pristine ZnO films

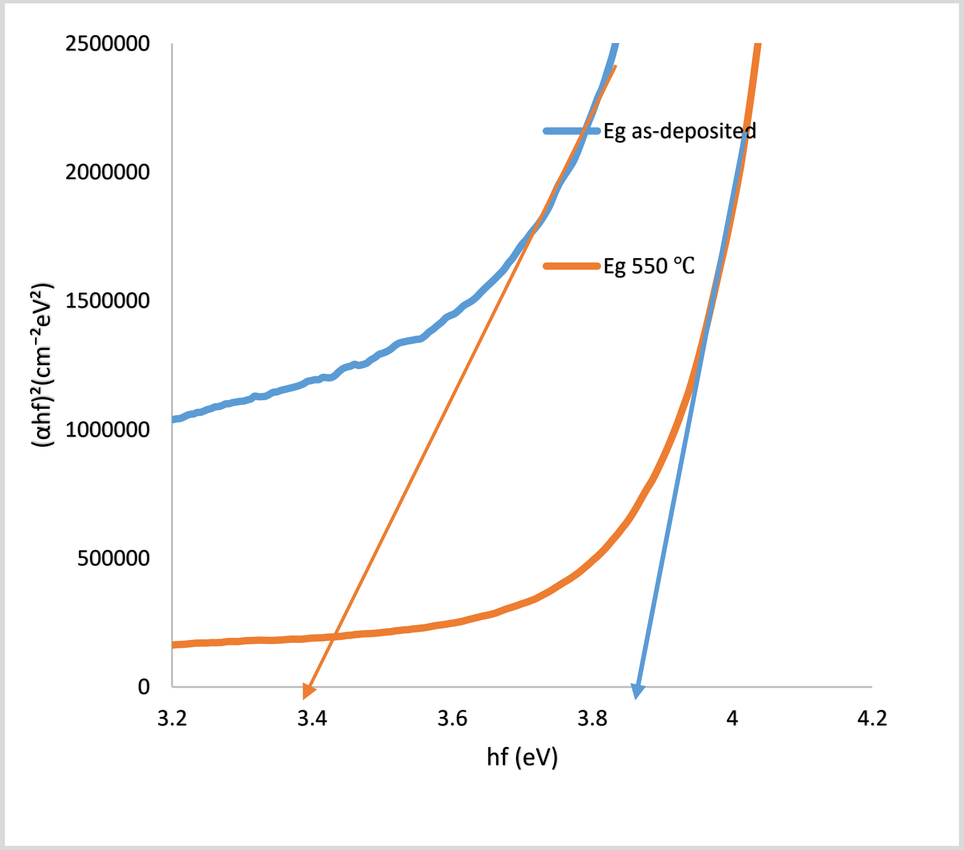

FIGURE 10: The plot of $(\alpha hf)^2$ against energy photon (hf) for annealed and as-deposited ZnO films

Surface Morphology of ZnO Thin Films

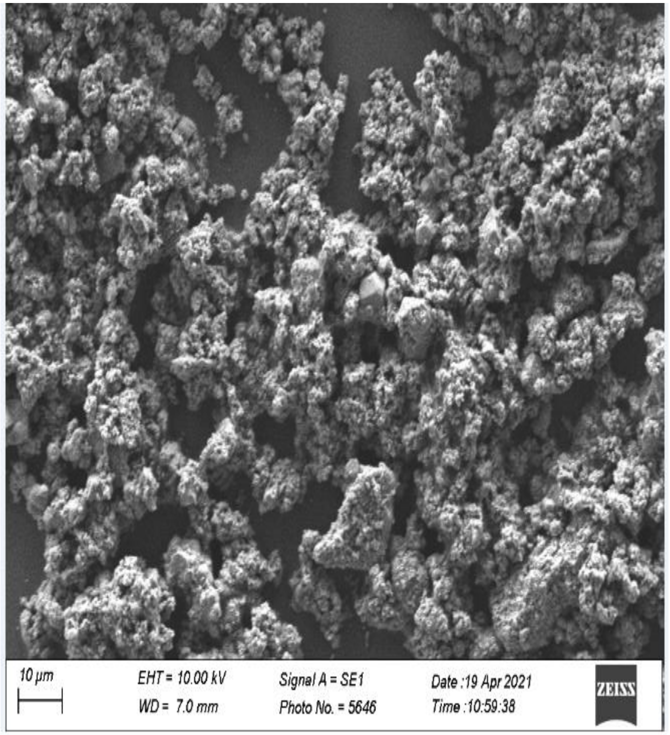

Figure 11: SEM micrograph of as-deposited pristine ZnO film

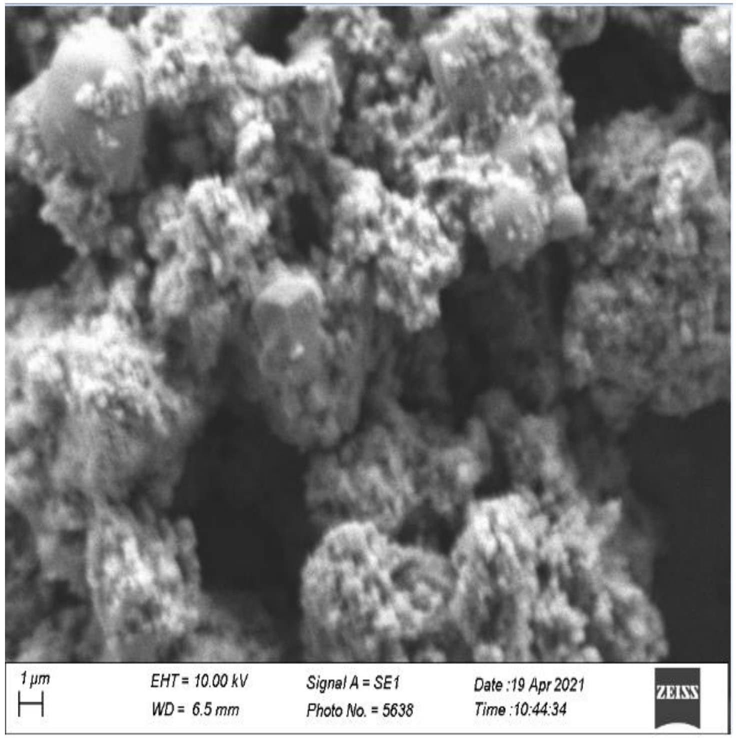

Figure 12: SEM micrograph of PEG- modified ZnO film

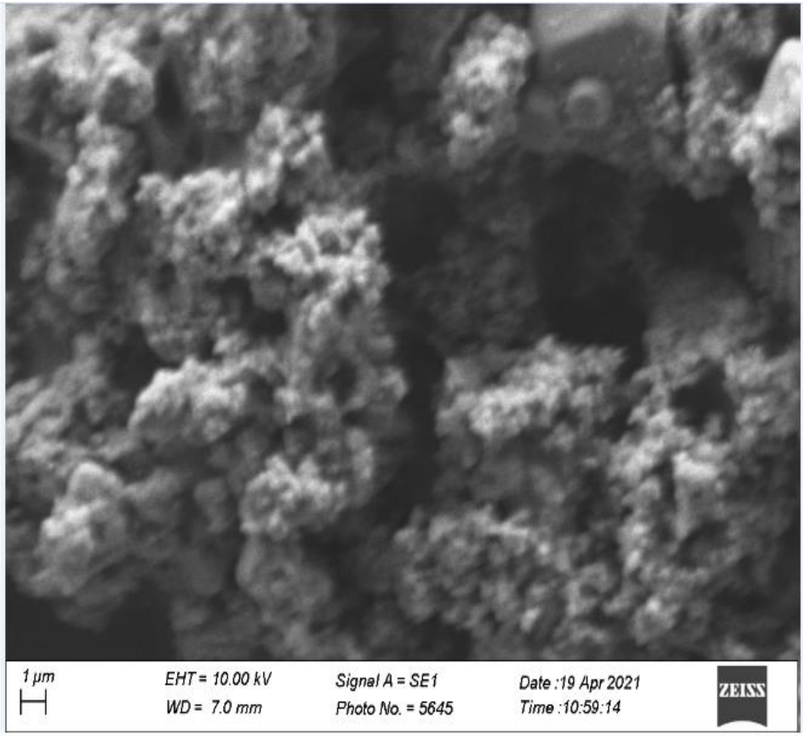

Figure 13: SEM micrograph of pristine ZnO film annealed at 550 °C

CONCLUSION

- Zinc Oxide (ZnO) thin films were prepared through sol-gel spin-coated route modified with polyethylene glycol (PEG) and annealed at 550 °C for one hour. The influence of PEG surfactant, and annealing temperature on ZnO films were analyzed by UV-Vis spectroscopy, XRD and scanning electron microscopy (SEM).

- Annealing treatment increases optical transmittance of ZnO films and decreases absorption features of ZnO films relative to unannealed and increase optical band gap of ZnO films

- PEG addition modified ZnO optical behavior - reduce optical transparency in the visible range, leads to shift in light absorption band edge towards longer wavelength, and narrows the band gap of ZnO films.

- The SEM studies reveal a dense and porous particles of PEG-modified ZnO surface structure films and XRD result exhibits improved crystallinity of annealed sample (ZnO film).

RECOMMENDATIONS

Electronic and optoelectronic devices applications; solar cells, light emitting diode (LED0, and photodetector (Jung *et al*., 2013 & Al-Hardan *et al*., 2014).

THANKS FOR LISTENING