

# Film thickness effect on structure and optical properties of nanostructured ZnS thin films deposited by spray technique

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## Abstract

In this work, the sprayed ZnS thin films were deposited on glass substrate at 400°C using ultrasonic spray chemical technique (SPC). The effect of film thickness on structure and optical properties of nanostructured ZnS thin films was investigated. From XRD analysis, it was observed that the prepared material has a hexagonal structure with good crystallinity. This finding was in a good agreement with the morphological properties in the SEM images. It was also found that the maximum crystallite size is 45.3 nm, which was obtained with 577 nm film thickness. From optical experiments, ZnS thin films have a good transparency in visible region and the band gap energy of all deposit films was varied in the range 3.9-4.1 eV.

## Introduction

Based on latest researches, on the investigation of new material to be used in cell solar application, various nanostructured materials composed of binary semiconductor compounds, such as  $\text{In}_2\text{O}_3$ ,  $\text{ZnO}$ ,  $\text{Cu}_2\text{O}$ ,  $\text{SnO}_2$  and  $\text{CdO}$ , have been investigated for several applications. Naturally, ZnS, which belongs to II-VI compound semiconductors, has been under extensive research in recent years because of its wide technological applications. Among these material applications, ZnS has been employed in optoelectronic devices and piezoelectric fields. It has a high transparency and good conductivity, as well as chemical and mechanical stability. ZnS has been intensively studied as a promising material for cell solar because of its wide band gap (3.5-3.8 eV) and high stability that are similar to ZnO ones.

## Results

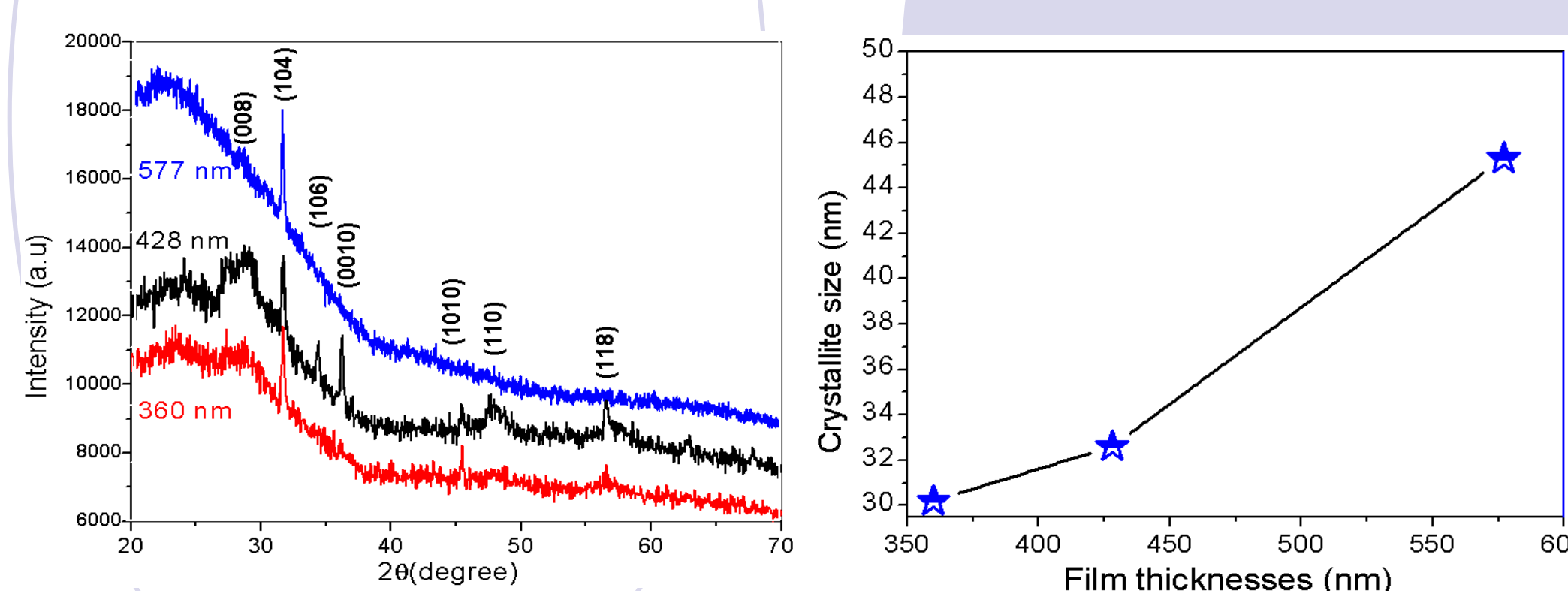


Fig. 1. XRD spectra of ZnS thin films for various films thickness.

Fig. 2. Variation of crystallite size of ZnS thin films for different films thickness

- ✓ Samples were indexed in hexagonal system.
- ✓ At 577 nm. Intensification of (104) peak which seems to reveal that the film is mono oriented along [104] direction.
- ✓ The crystallite size increase with film thickness.

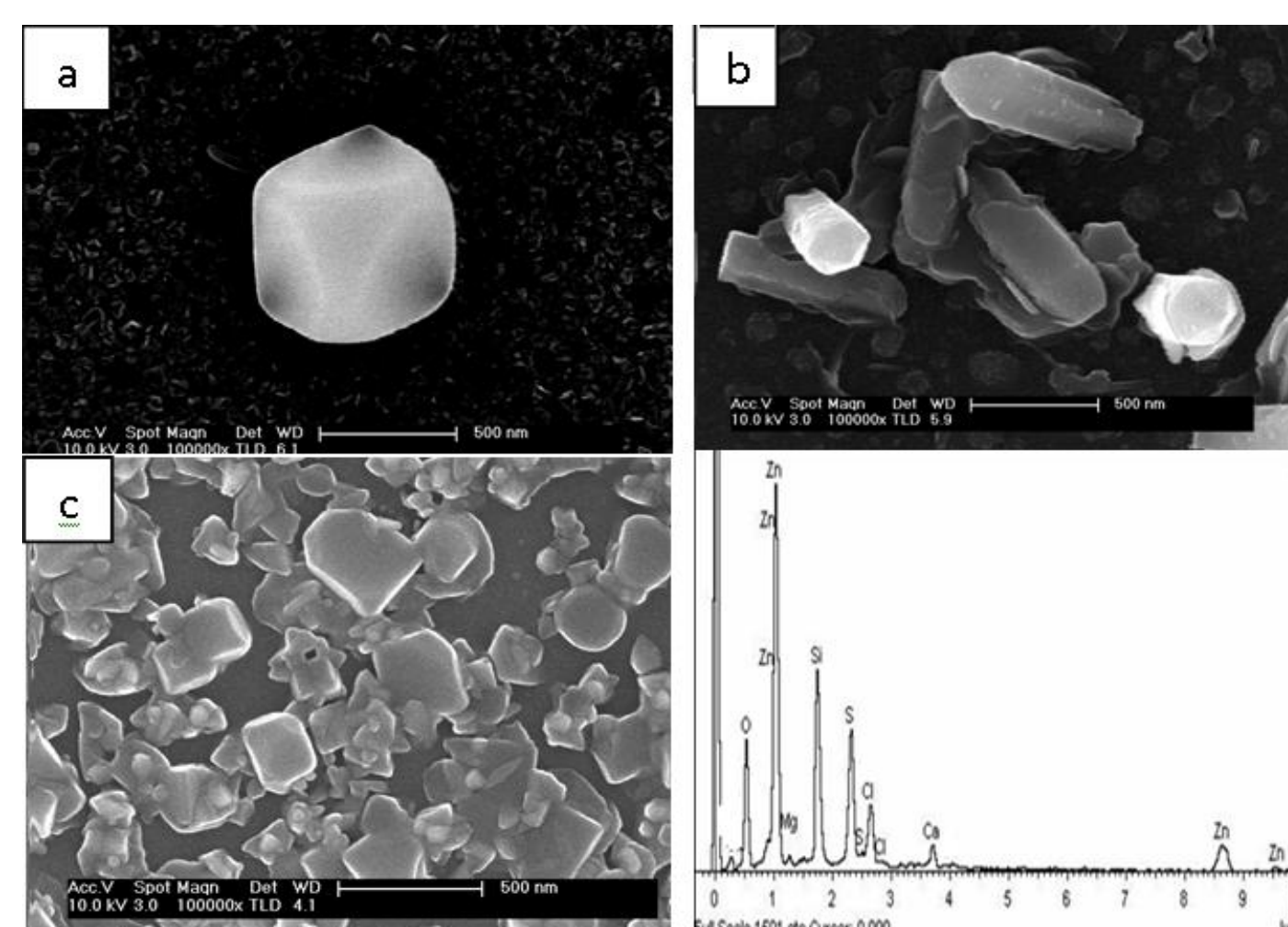


Fig.3. SEM images and typical EDX spectrum of ZnS thin films

SEM images show hexagonal shape of ZnS films which are in agreement with the wurtzite hexagonal phase found by XRD results, note that for 577 nm thickness different shape are has been seen

## Experimental

(0.05-0.1)M Ac(Zn) 0.1M Thiourea

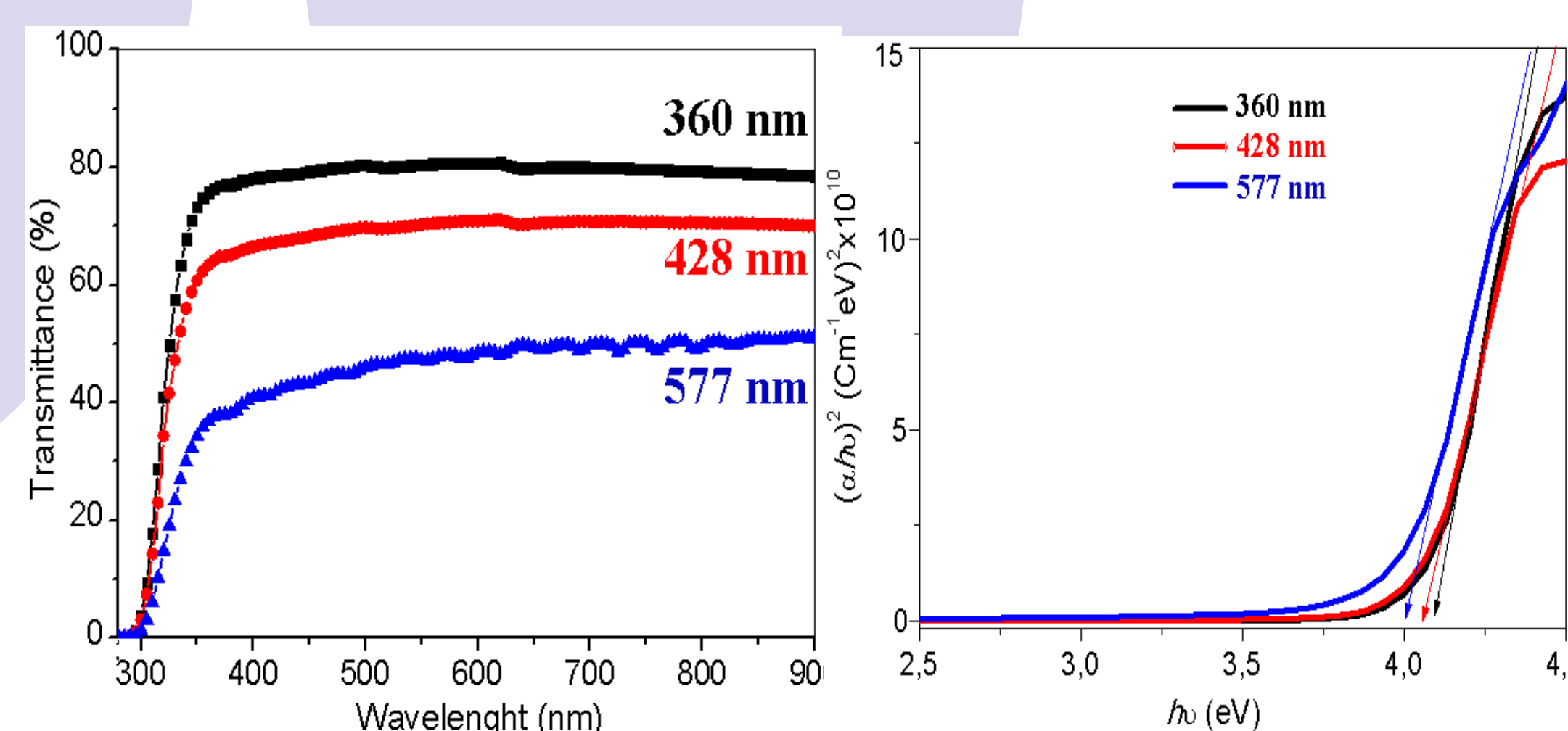
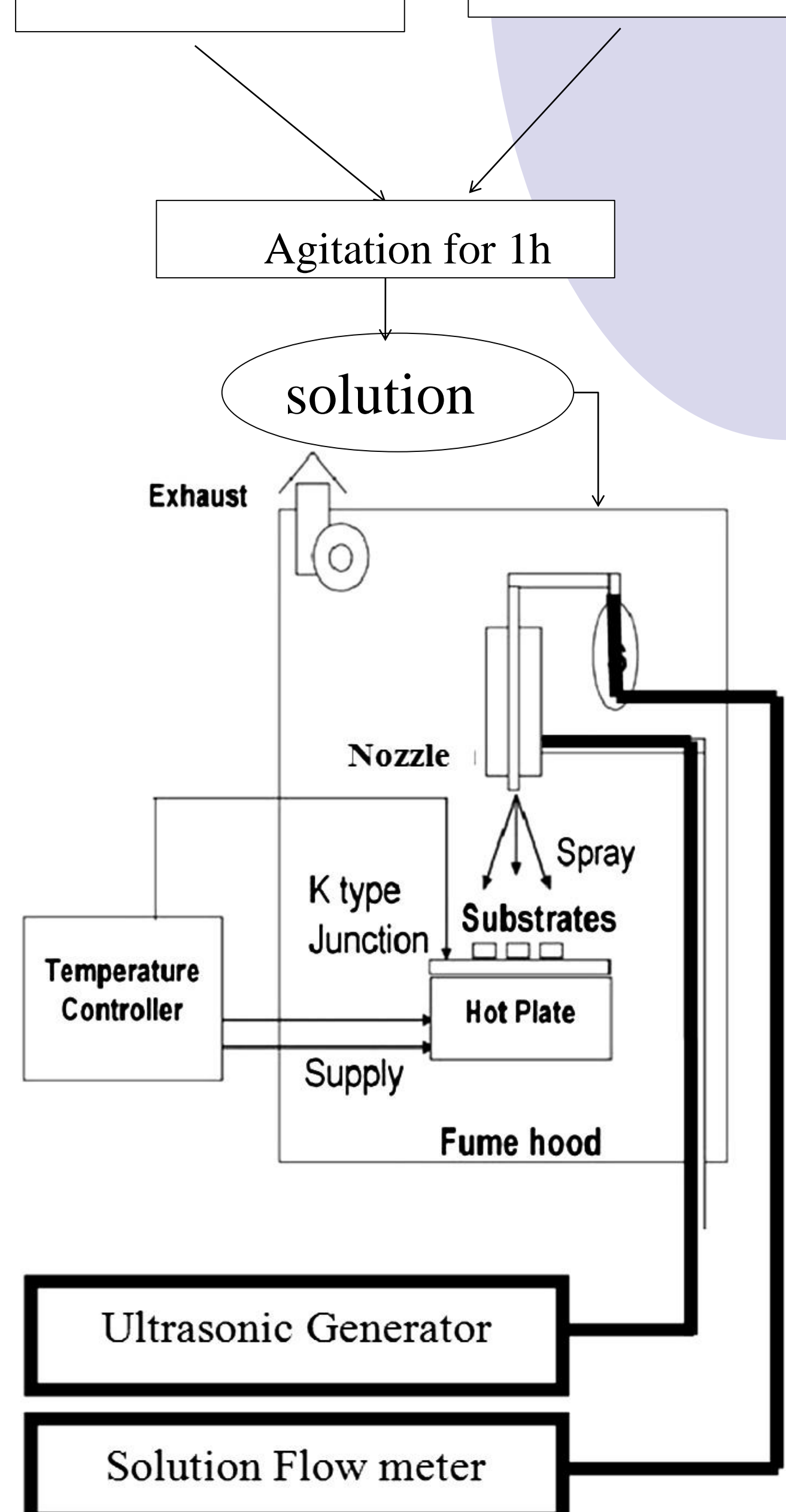


Fig. 4. Optical transmission spectra of ZnS for different films thickness

Fig. 5. Band gap of ZnS thin films for different films thickness.

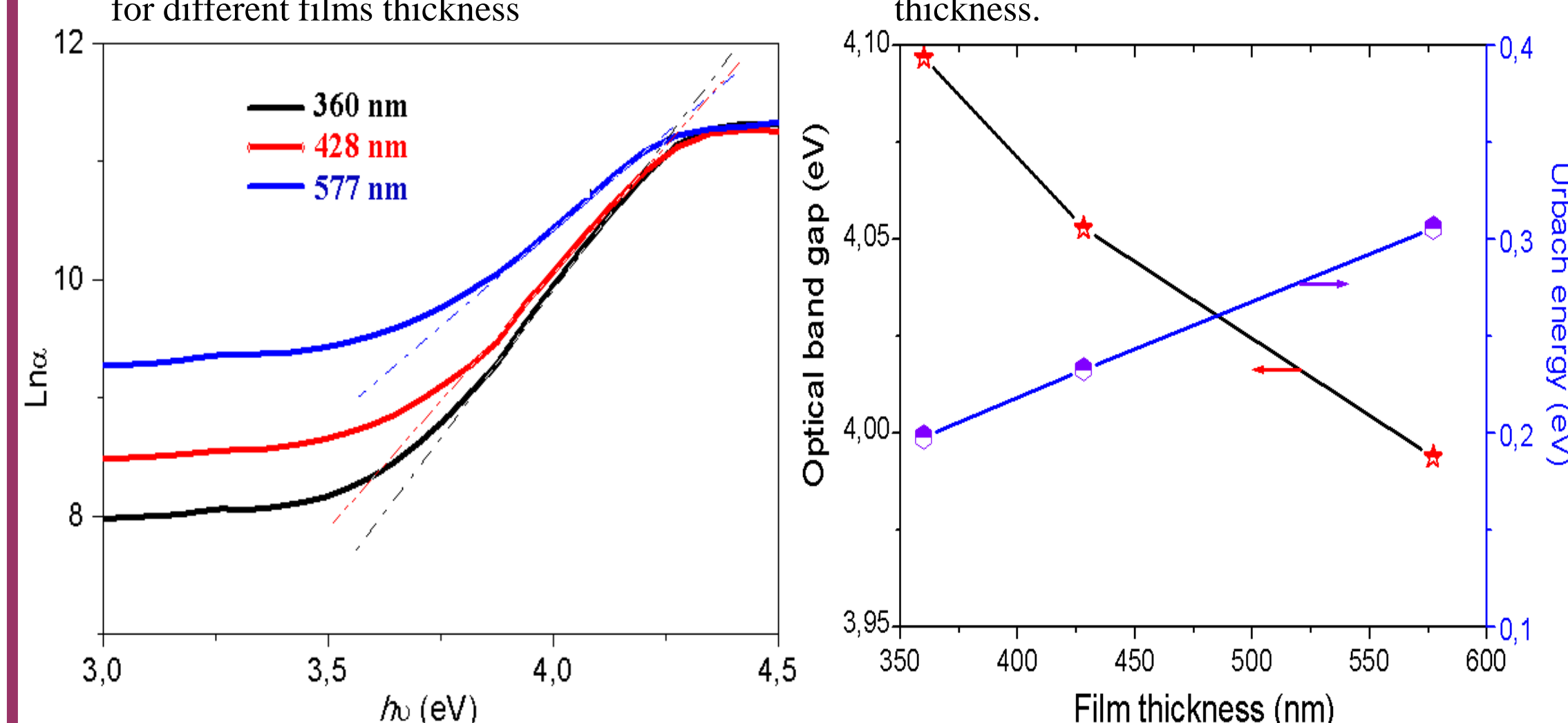


Fig. 6: Urbach energy deduction for different films thickness

Fig. 7: Variation of Band gap and Urbach energy of ZnS thin films of different film thickness.

## Conclusion

- From XRD analysis, a hexagonal structure of ZnS with good crystallinity was confirmed.
- The crystallite size maximum is 45.3 nm was obtained with 577 nm film thickness.
- From optic measurements in visible region, ZnS thin films have a transparency of 50-80%, the band gap energy of all deposit films were varied in rang 3.9 to 4.1 eV. At lower film thickness, the ZnS thin films become less disorder and fewer defects.