Structural and optical properties of the Sm^{3+} doped $ZnAl_2O_4/ZnO$ mixed phases synthesized via precipitation method

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Overview

- **Background and Introduction**
- **Applications**
- **Aim of this study**
- **Experimental**
- **Results**
- **Conclusion**

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Background and Introduction

- ***Why $ZnAl_2O_4/ZnO$?***

  Exhibit enhanced performance due to their synergistic effects

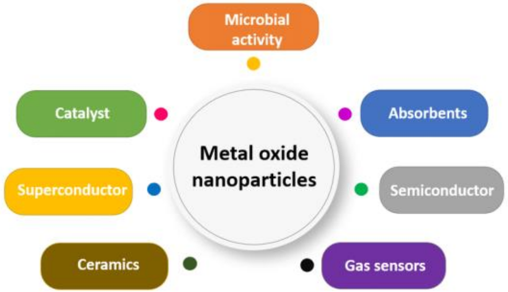
  Improved thermal stability

  High efficiency

  Cost-effective

- **Samarium (Sm^{3+}) luminescent activator with a reddish-orange emission.**

- **Doping = strong luminescence intensity.**



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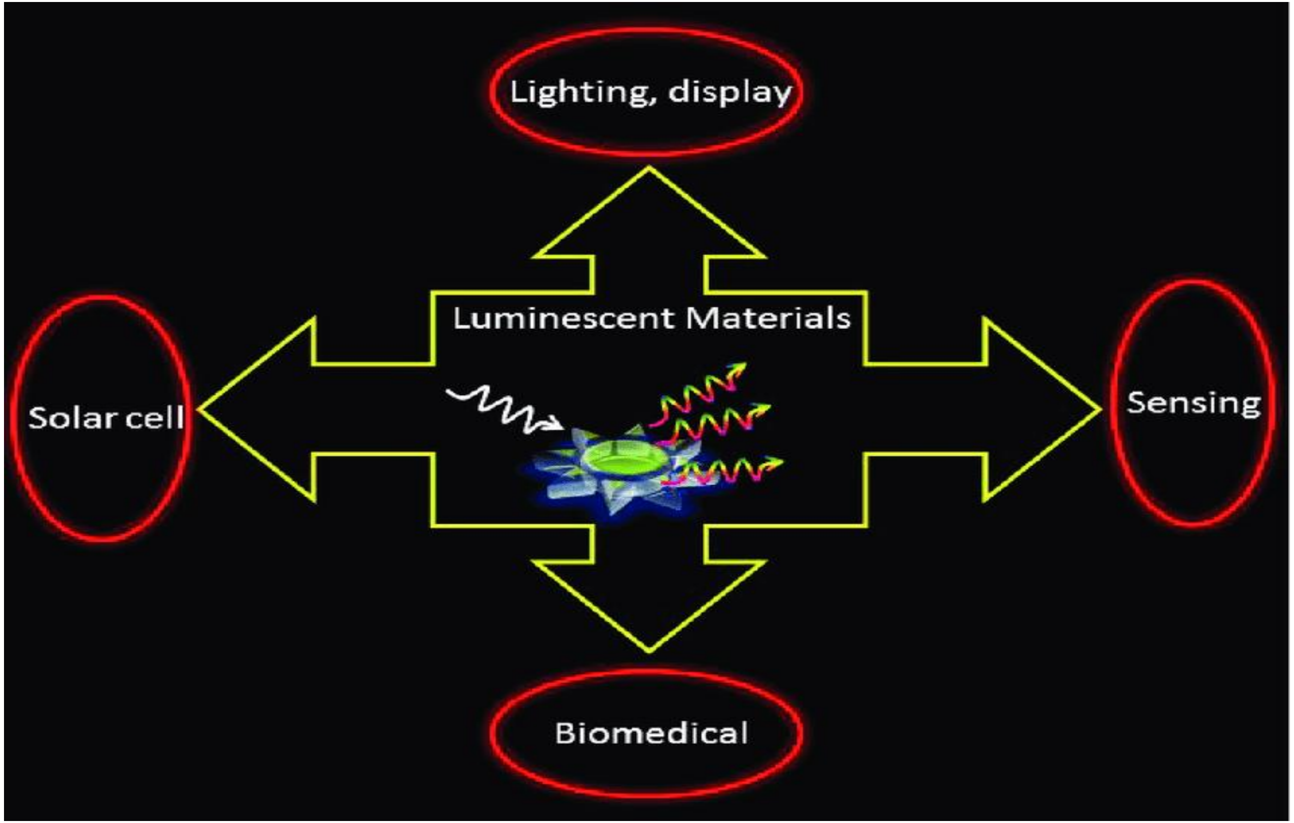
Applications



Aim of this study

- **This study aims to investigate the influence of varying the Sm^{3+} concentration on the $ZnAl_2O_4/ZnO$ mixed phases.**

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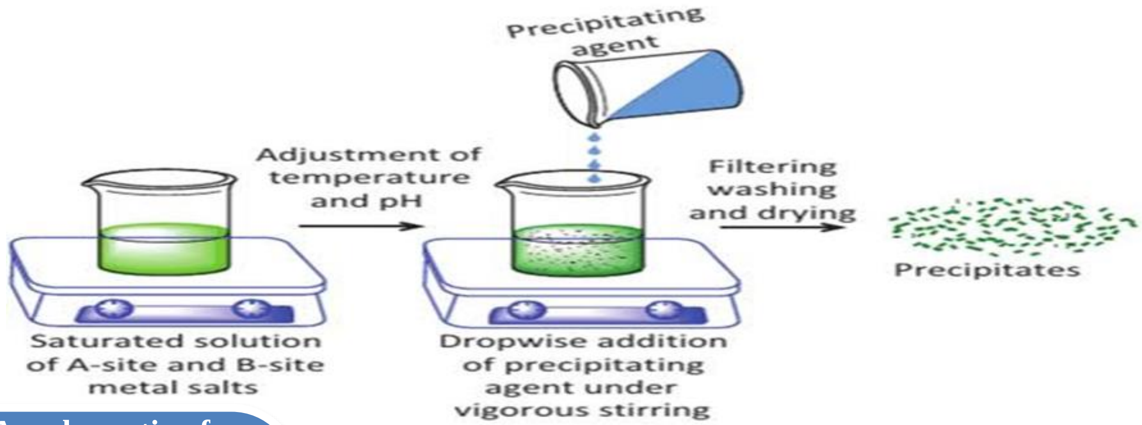
Experimental



A molar ratio of Zn: Al 1:0,5

$Al(NO_3)_3 \cdot 9H_2O$

$Zn(CH_3CO_2)_2 \cdot 2H_2O$

Deionized H_2O

NH_4OH

$Sm(CH_3CO_2)_3 \cdot x(H_2O)$

Stirred until the pH was 8.5

→ Filtered, washed and dried for 48 h

→ Annealed at 750 °C for 3 ½ h

→ Characterizations:

- XRD
- SEM-EDS
- UV-VIS
- PL
- CIE

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Results

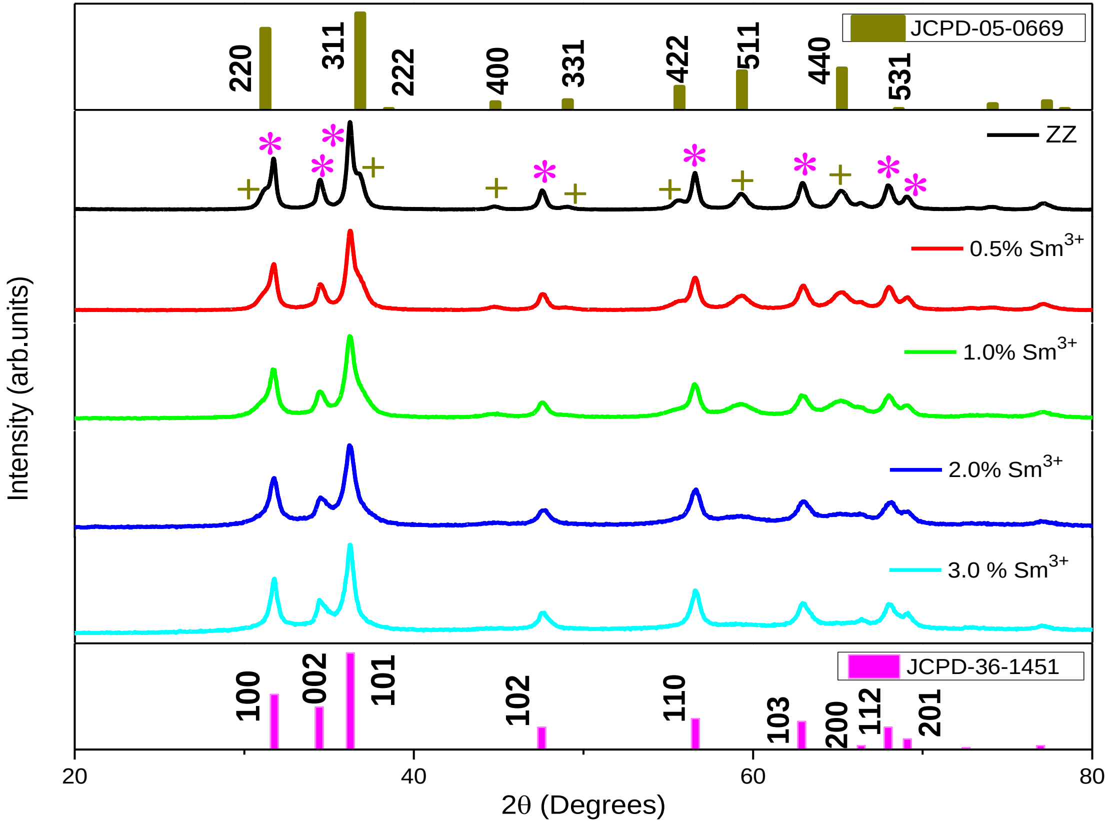

Figure 1: XRD diffraction of the undoped and Sm^{3+} doped ZZ samples.

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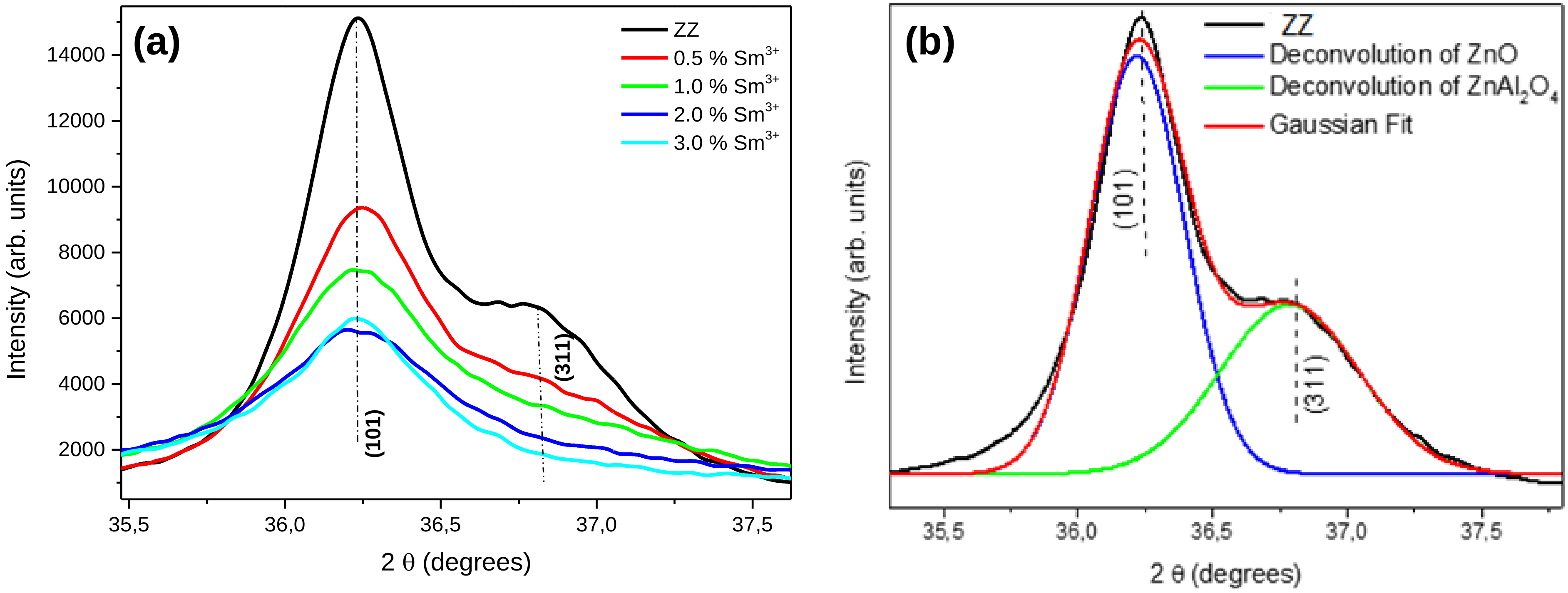

Figure 2: (a) Zoomed version ZnO (101) and $ZnAl_2O_4$ (311) diffraction peaks (b) Deconvolution of the most intense diffraction peak for the undoped ZZ sample

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Table 1: Calculated average crystallite size

[Sm^{3+}](%)	Crystallite size (nm)	
	$D_{ZnAl2O4}$	D_{ZnO}
Undoped	**13**	**33**
0.5 %	**14**	**15**
1.0%	**14**	**12**
2.0%	**12**	**10**
3.0%	**-**	**17**

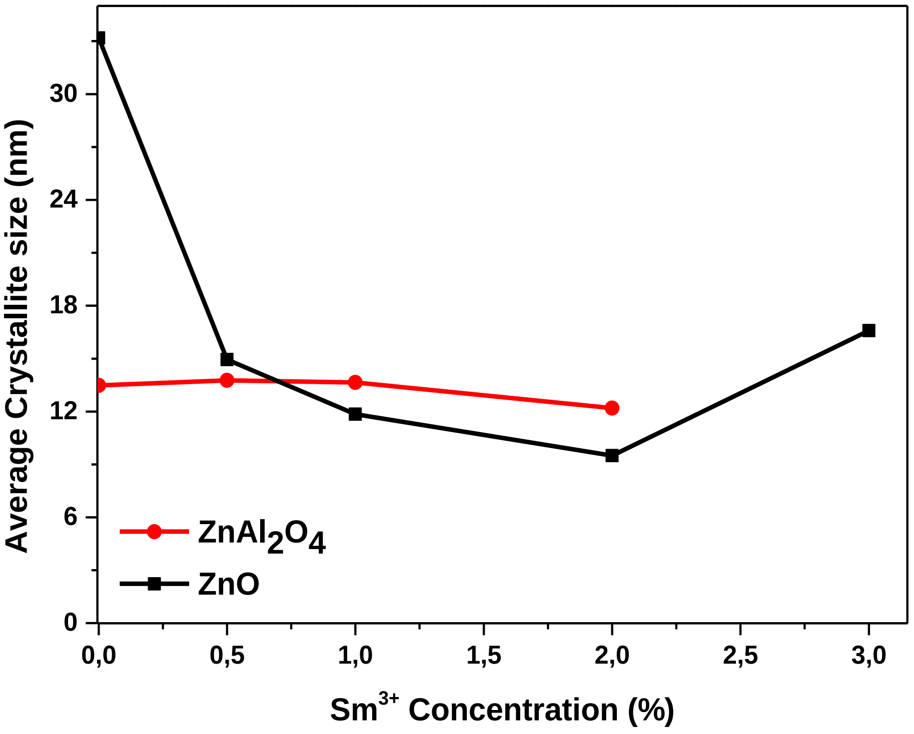

Figure 3: Average crystalline size as a function of Sm^{3+} concentration.

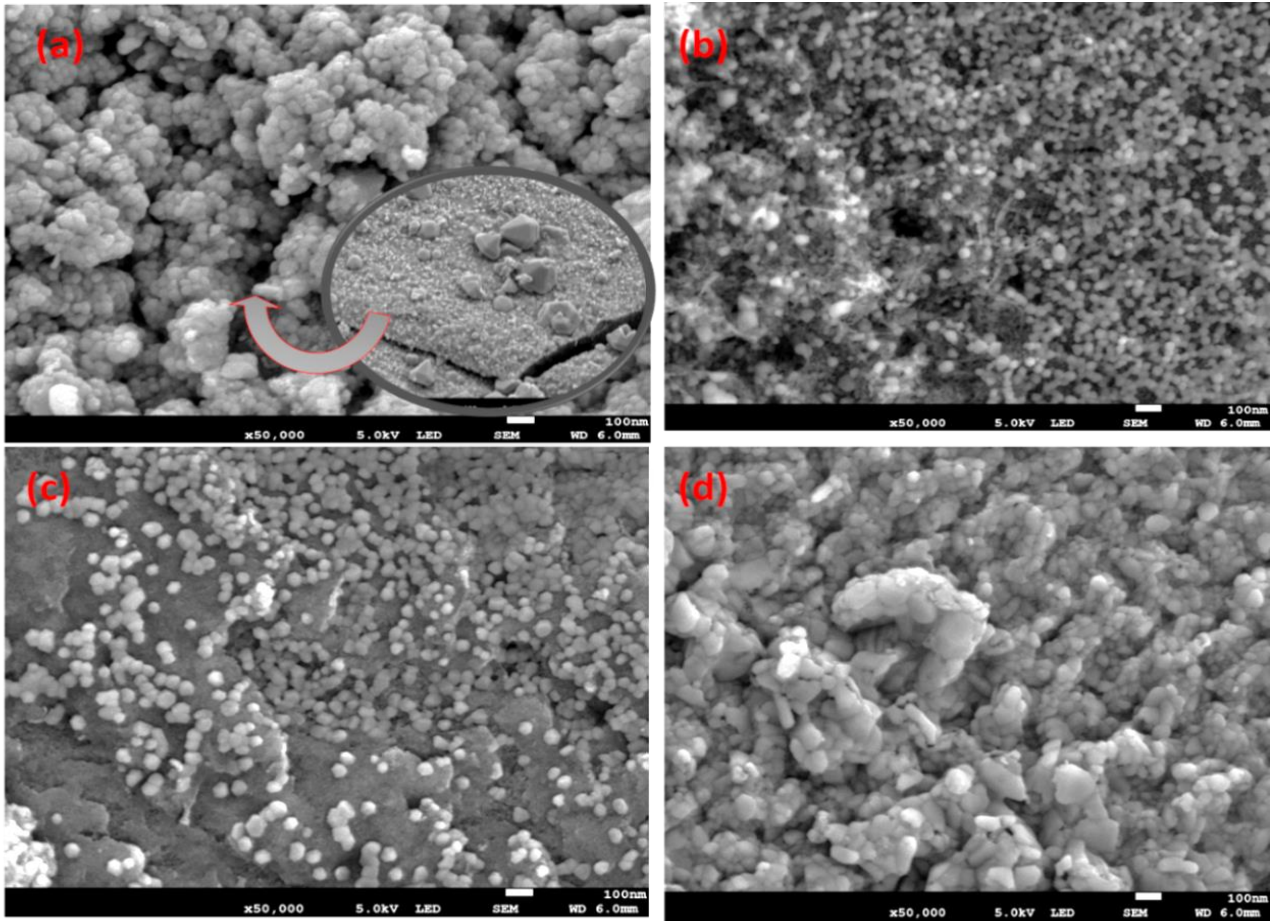

Figure 4: SEM micrographs of the (a) undoped ZZ, (b) 1.0%, (c) 2.0%, and (d) 3.0 % Sm^{3+} doped samples.

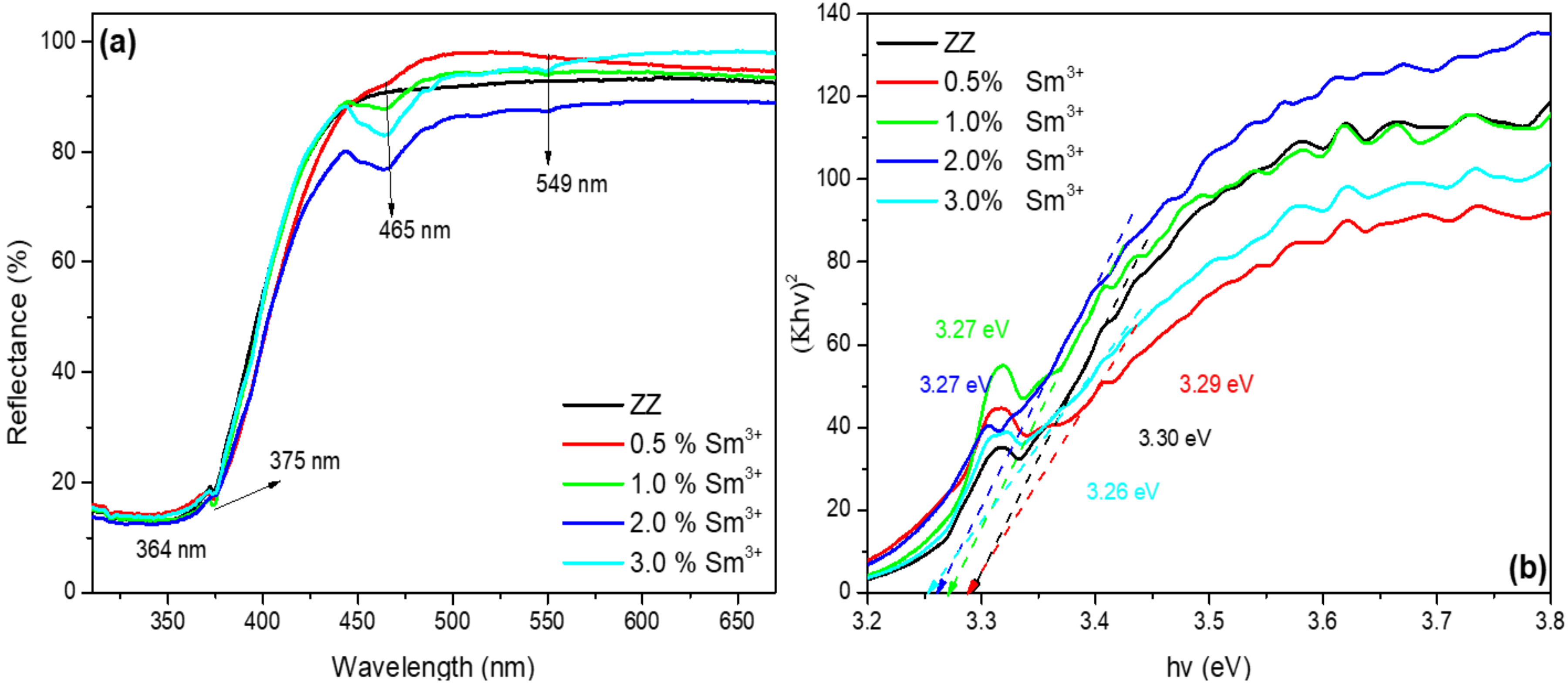

Figure 5: (a) UV-vis reflectance spectra; (b) Plot to determine the bandgap of the ZZ and Sm^{3+} doped nanopowders

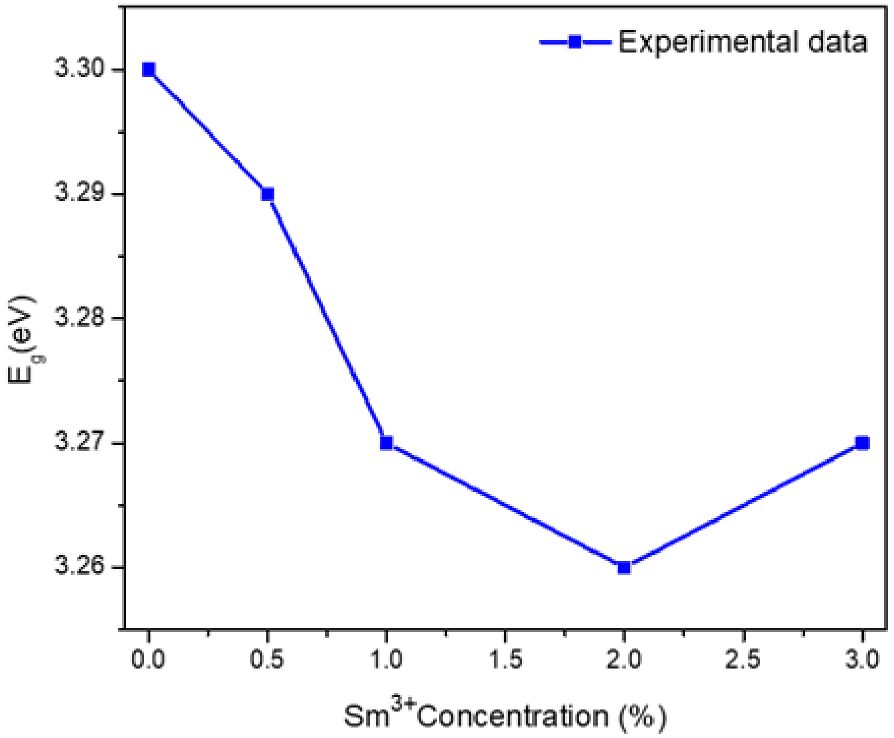

Figure 6: Bandgap as a function of Sm^{3+} concentration.

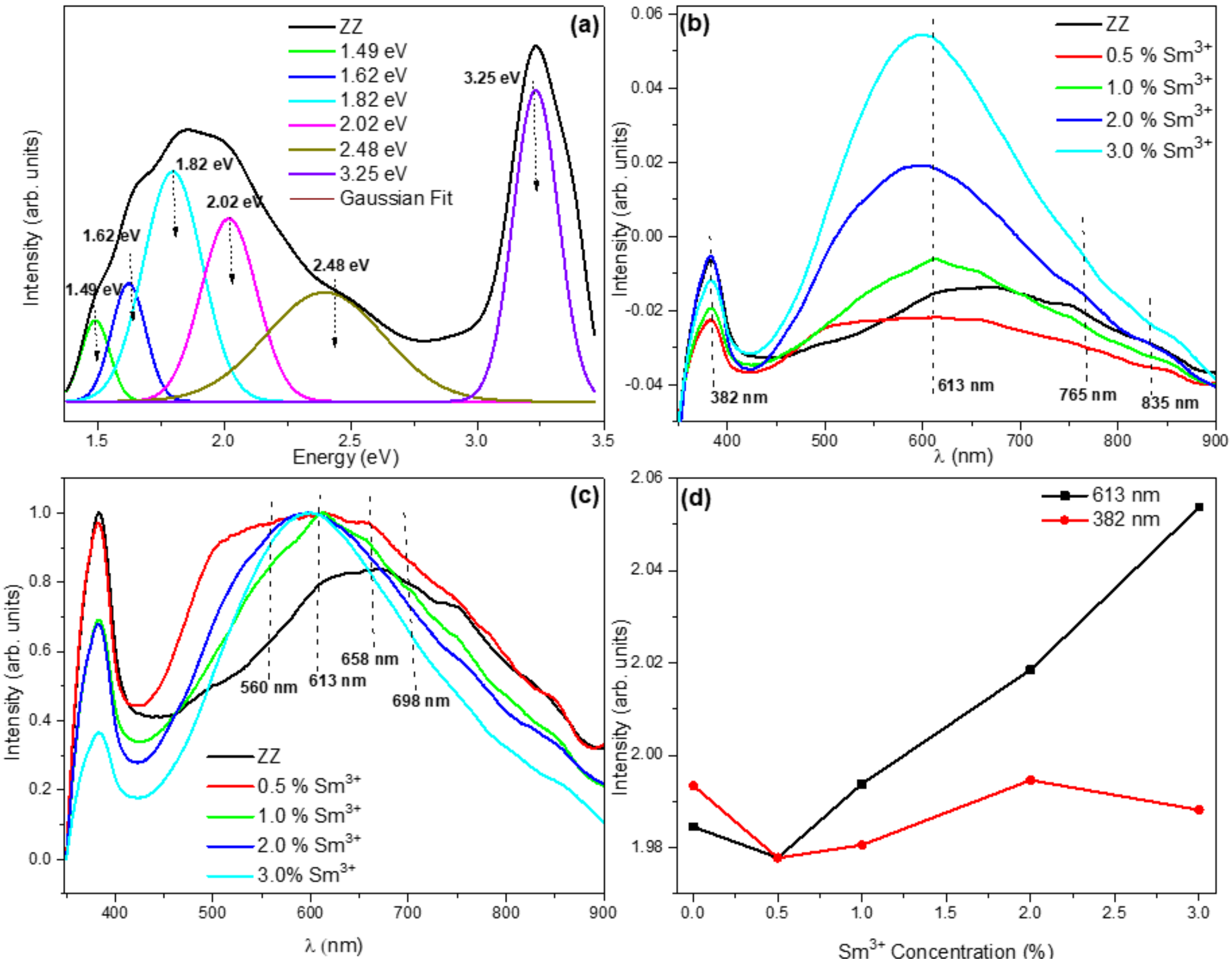

Figure 7: (a) Peak fitting of the undoped ZZ mixed phases;

(b) Emission spectra;

(c) Normalized emission spectra of the ZZ and Sm^{3+} doped nanopowders

(d) Graph of intensity versus the concentrations of Sm^{3+} ions at 382 and 613 nm.

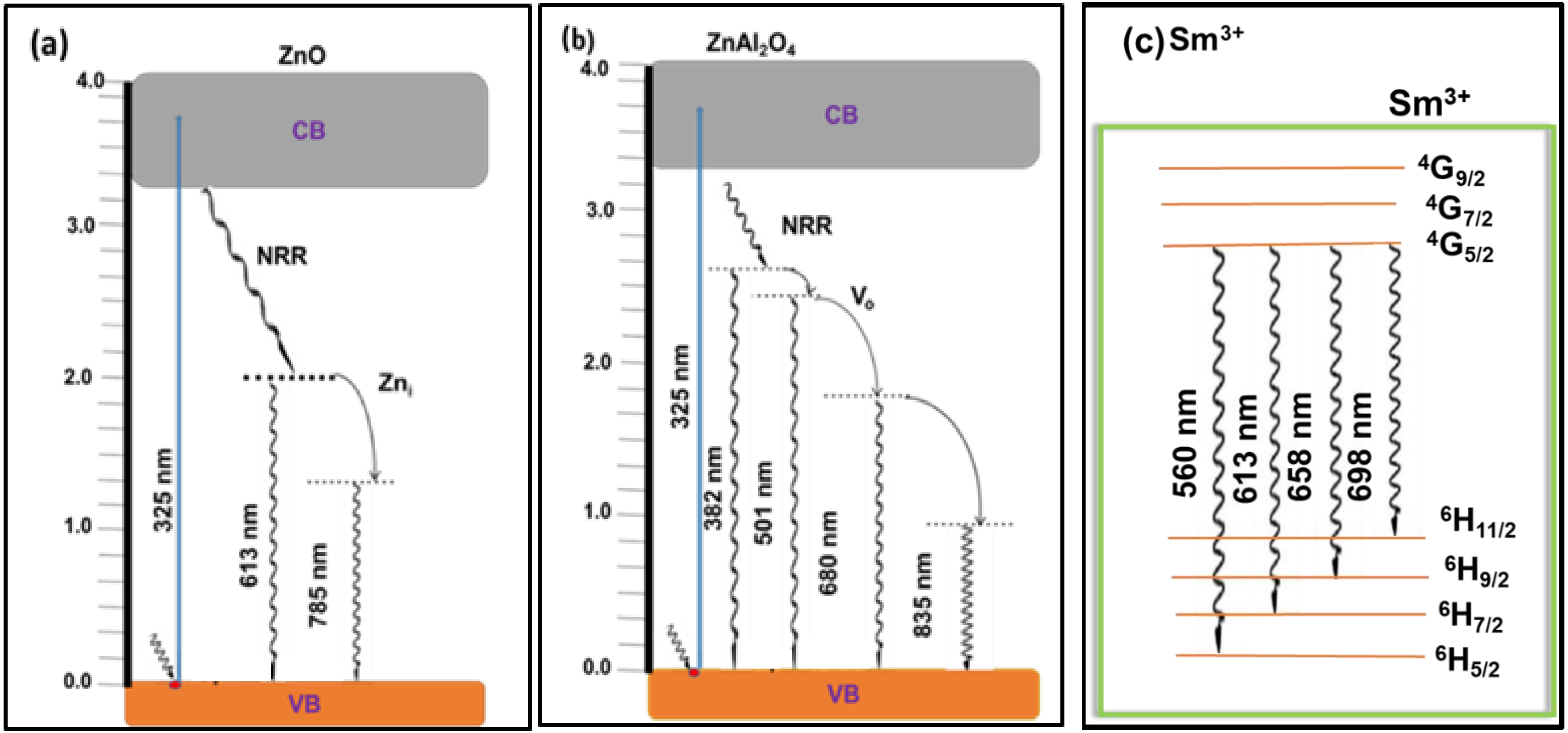

Figure 8: The anticipated emission pathway for the (a) ZnO, (b) $ZnAl_2O_4$ and (c) Ionic emissions of Sm^{3+}.

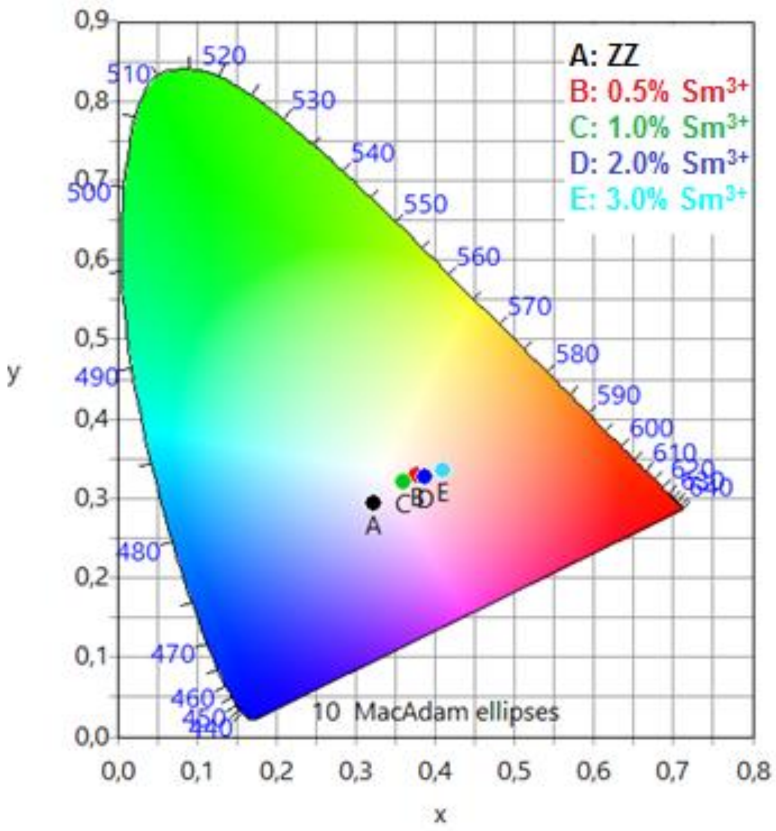

Figure 9: The CIE chromaticity diagram for the prepared nanopowders.

Conclusion

- **Mixed phases $ZnAl_2O_4$/ZnO (ZZ) nanopowders were prepared using precipitation and annealed at 750 °C for 3½ hrs.**
- **XRD results revealed a phase transition from cubic $ZnAl_2O_4$ to a hexagonal wurtzite phase**
- **The surface morphology of the samples was influenced by varying the Sm^{3+} concentration.**
- **The E_g decreased with an increase in the Sm^{3+} concentration.**
- **PL showed emission peaks attributed to the ZnO, $ZnAl_2O_4$ and Sm^{3+} transitions and Sm^{3+} concentration influenced the luminescence intensity and emission wavelength.**
- **The CIE chromaticity diagram indicated that varying the Sm^{3+} concentration could adjust the emission colour.**

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Thank you

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