# SYNTHESIS OF CdMgZnO NANOPARTICLES AS A POSSIBLE HOST FOR NANOPHSPHOR APPLICATION FOR NEAR-UV AND BLUE LED CONVERTED WHITE LIGHT EMITTING DIODE AND ITS APPLICATION TO GENERAL LIGHTING

O. Kalu[1,3], J.A. Duarte Moller.[2] , A. Reyes-Rojas[1]
[1] Centro de Investigación en Materiales Avanzados, S.C, Miguel de Cervantes120, Complejo Industrial Chihuahua, Chihuahua, Chih. Mexico. 31136.
[2] Universidad De La-Salle Bajio, Escuela de Ingenieria Civi, Mecanica e industrial, Mexico
[3]Department of Physics, Federal University, Lafia, P.M.B 146 Nasarawa State, Nigeria
*Corresponding author: e-mail- kalu.onyekachi.kalu@cimav.edu.mx

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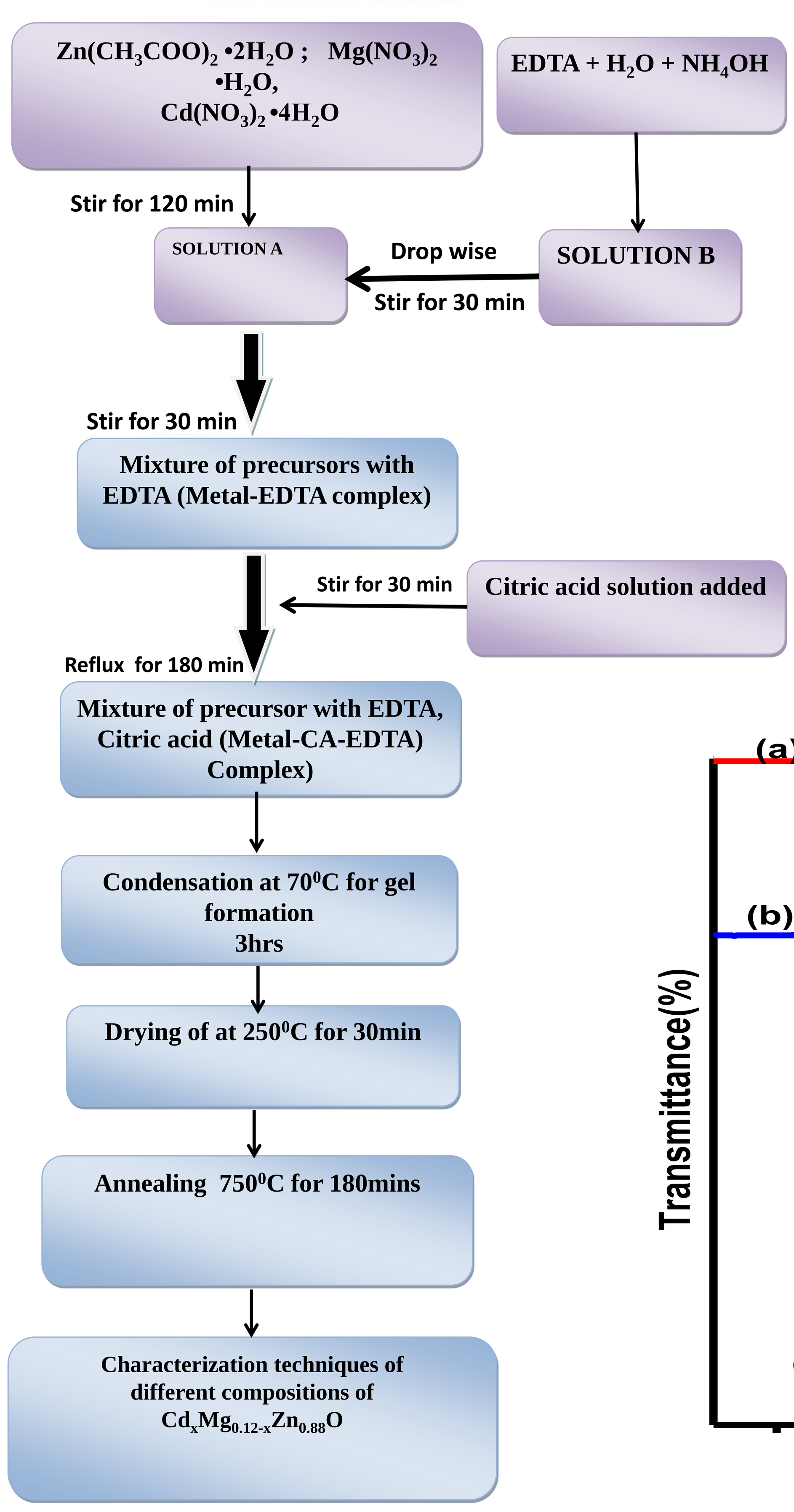
## ❖ INTRODUCTION

The red shift of the basic absorption peak centered at 375 nm (3.30 eV) to 432 nm (2.92 eV) in the UV-visible absorption spectra validates band gap narrowing of the CdMgZnO of nanoparticles. Microstructural experiment and structural adjustment with lower angle of diffraction peaks and vibrational stretching of Zn-O respectively in the lattice from the substitution of Cd makes it a suitable and a possible host for nanophosphor application in solid state lighting [1]

Furthermore, the impact of divalent metals (Mg and Cd) on semiconductor oxide nanostructure with respect to luminescence emissions in the visible spectra has the potential of being applied in light emitting devices, leaser devices, non-linear optical devices, flat panel displays, sensors, anti-reflecting coatings and IR windows [2]

## ❖ EXPERIMENTAL PROCESS

SYNTHESIS PROCESS




## CdMgZnO NANOPARTICLES CHARACTERIZATION AND RESULTS ANALYSIS

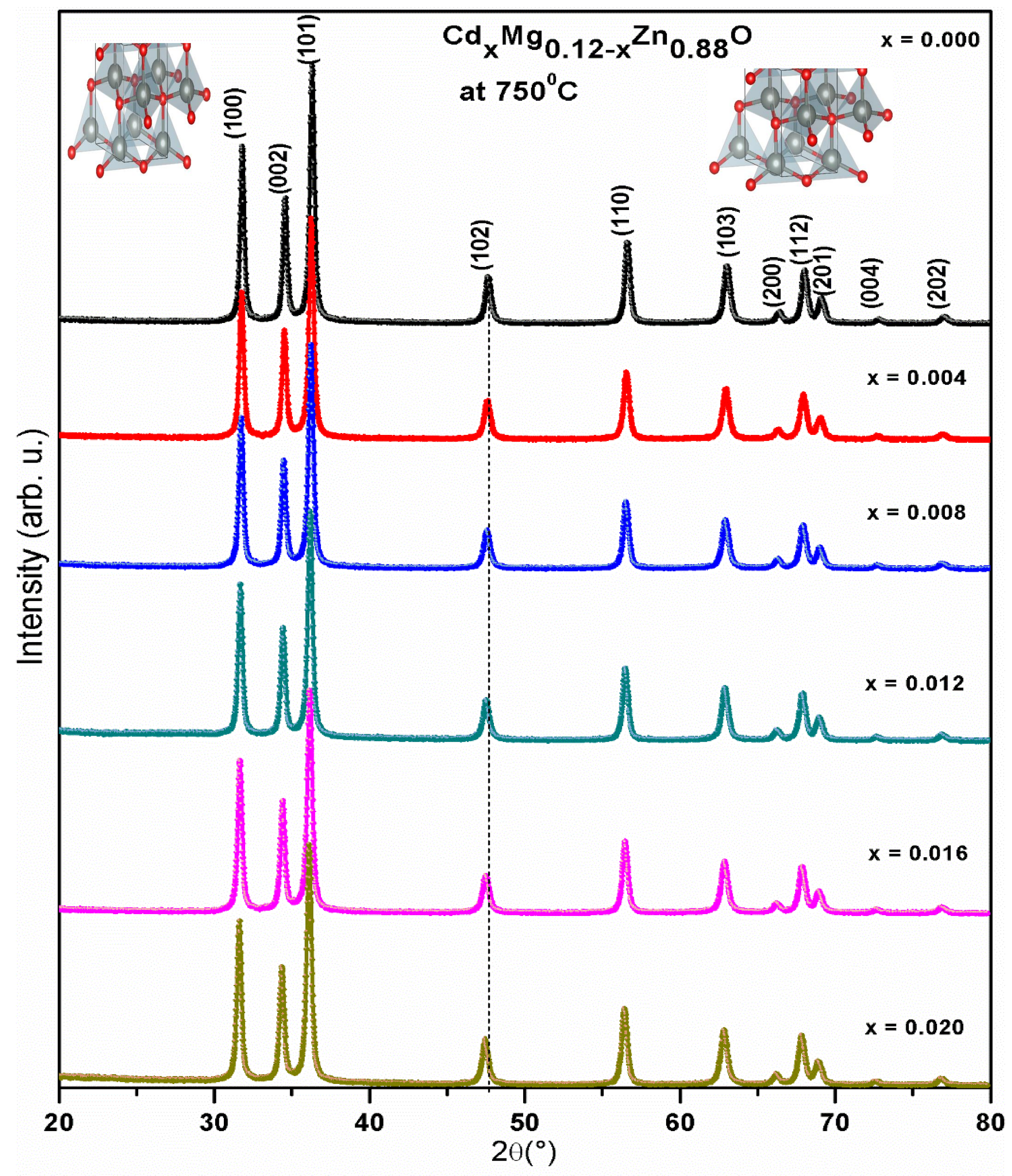



**Figure 1:**Plots of XRD Pattern of CdMgZnO .

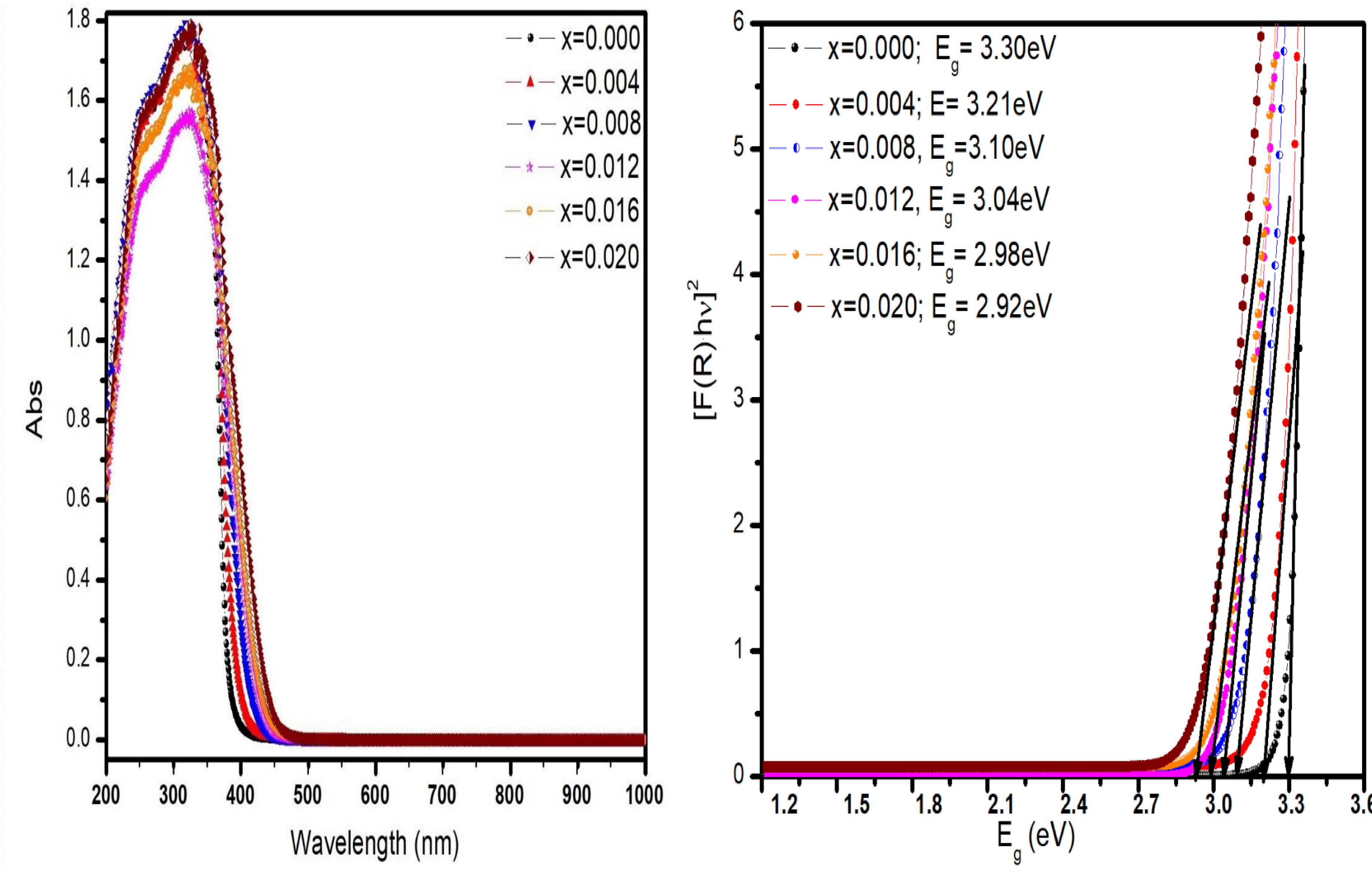



**Figure 2: UV-Vis-NIR absorbance and optical band-gap of CdMgZnO nanoparticles**

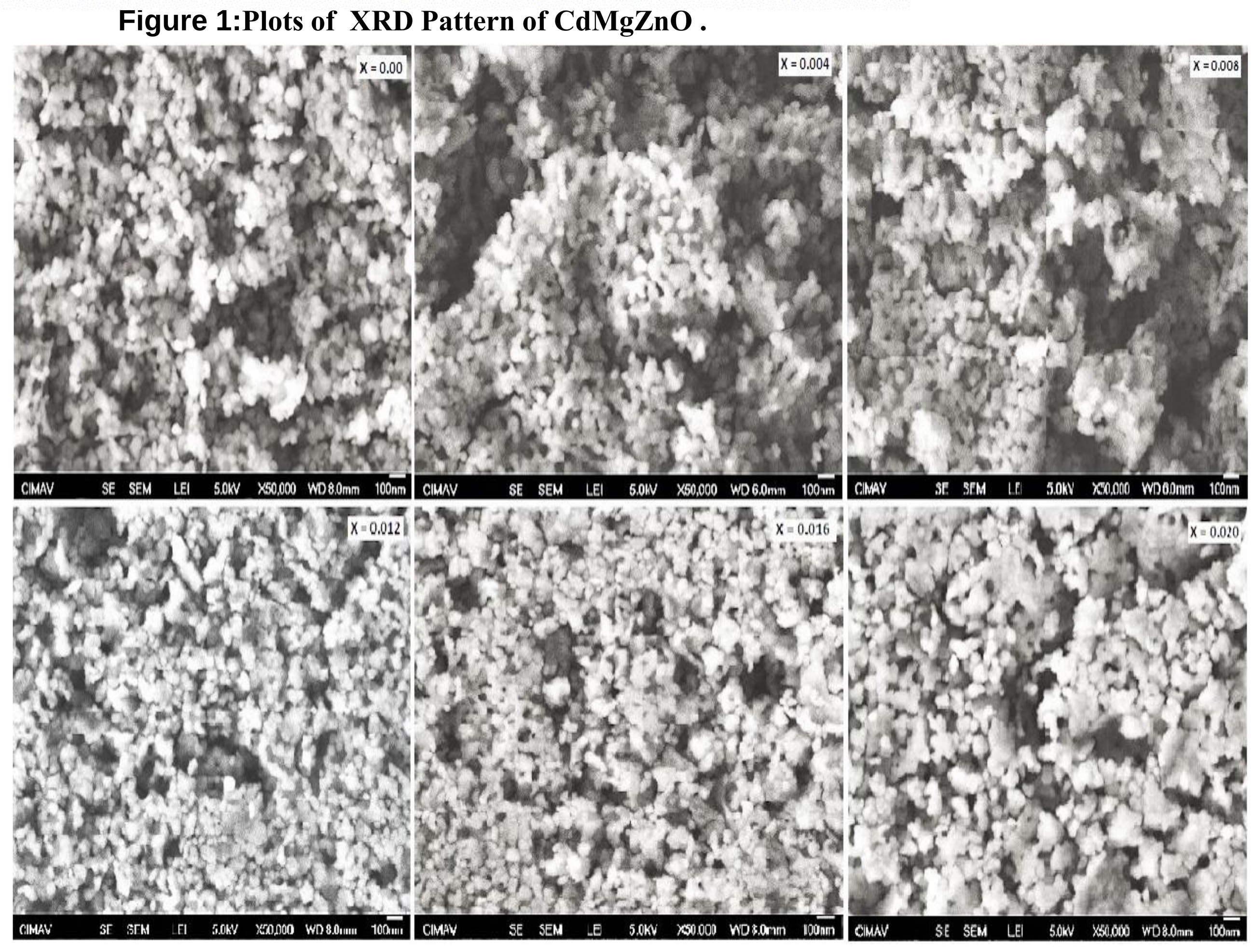


**Figure 3: (a) SEM micrographs of CdMgZnO nanoparticles**

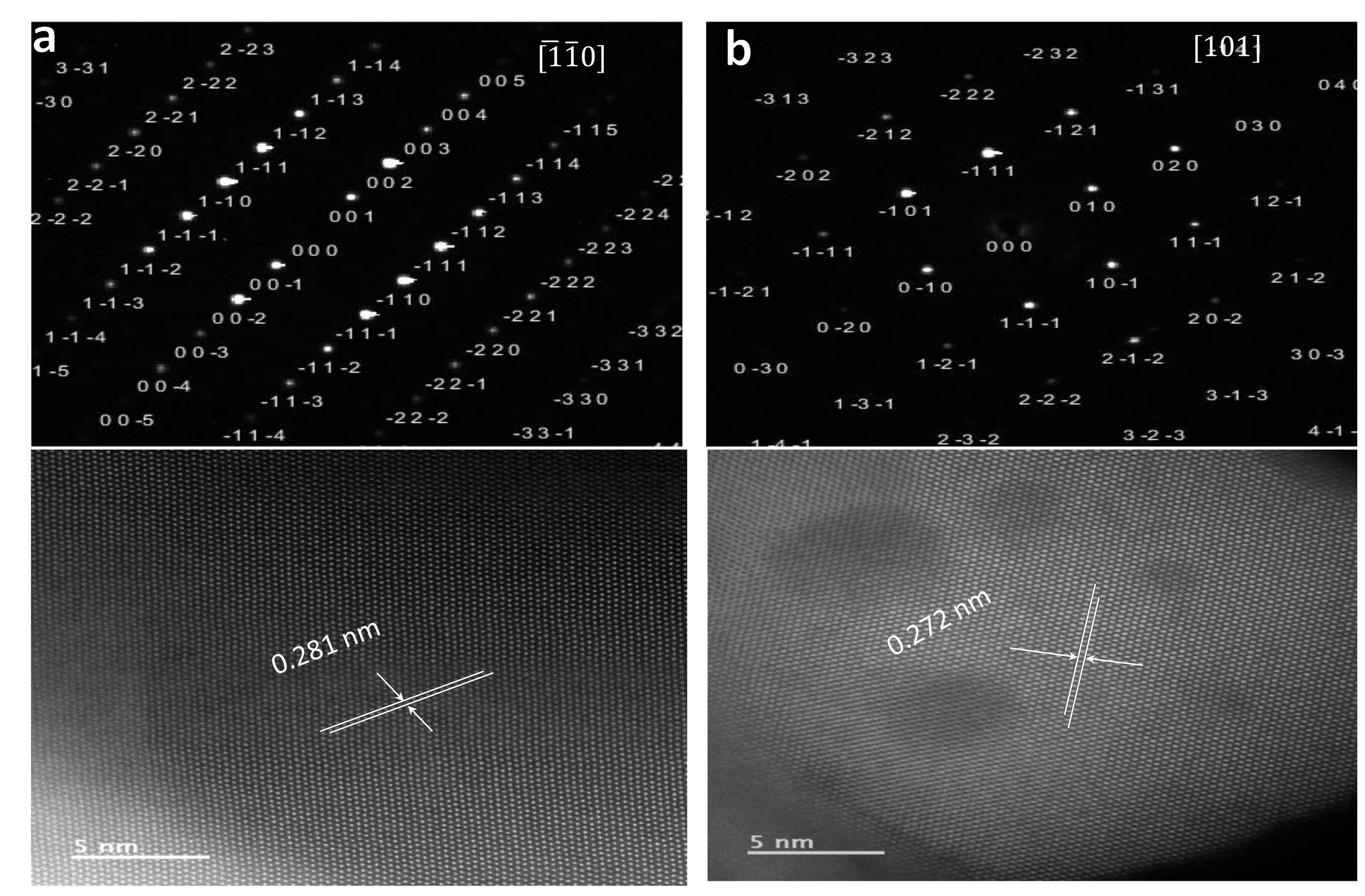



**Fig. 4:TEM images of $Cd_xMg_{(0.12-x)}Zn_{0.88}O$ nanoparticles. a) SAED pattern in the zone axes $[1\bar{1}0]$ and HRTEM for x = 0.02 (maximum concentration). b) SAED pattern in the zone axes [101] and HRTEM for x = 0. (without Cd concentration).**

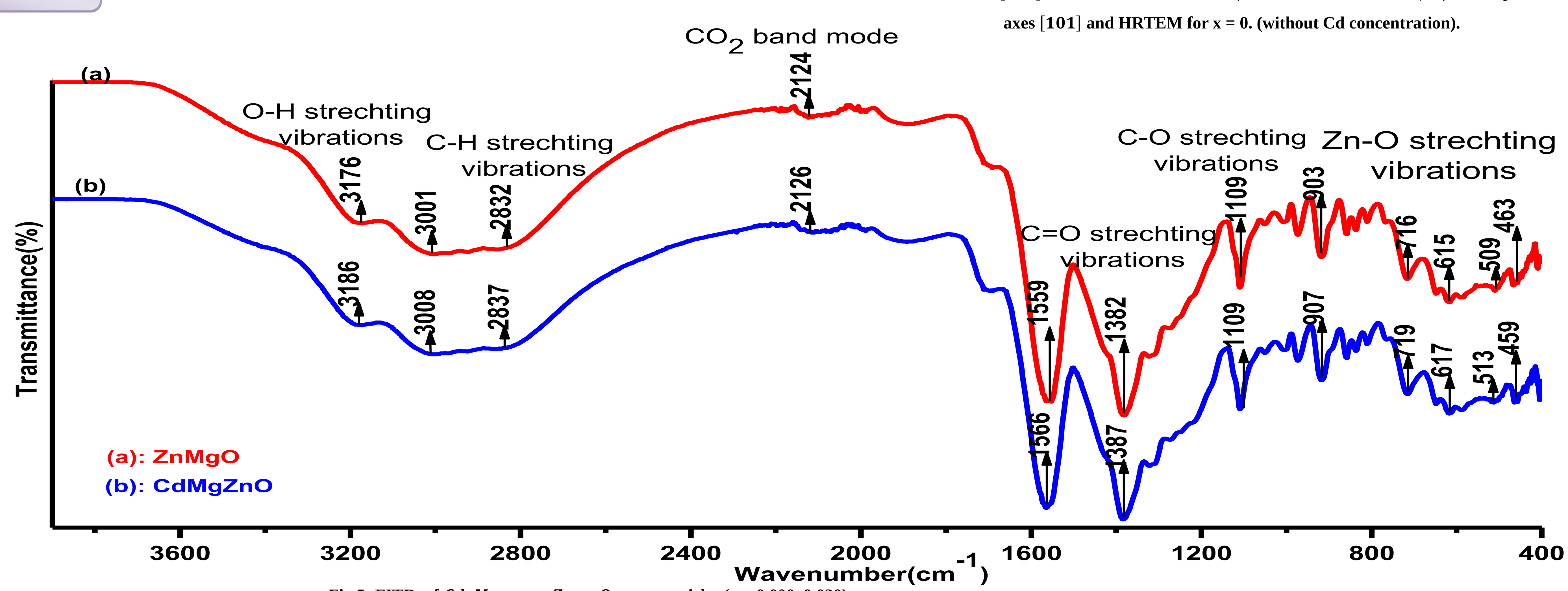



**Fig 5: FITR of $Cd_xMg_{(0.12-x)}Zn_{0.88}O$ nanoparticles (x = 0.000, 0.020).**

## ❖ DISCUSSION

- The entire XRD pattern matched to a (JCPDS 36-1451) standard, revealed a hexagonal wurtzite structure with a single phase crystal[2] as shown in Fig.1(a) with a degree of stress or strain in the synthesized nanoparticles since $Cd^{2+}$ ion has a lager ionic radius of $R^{2+}_{Cd}$ (0.095nm) to that of $R^{2+}_{Zn}$ (0.074nm) and $R^{2+}_{Mg}$ (0.072nm) respectively .
- The increase in the absorption wavelength may be linked with the presence of impure states below the conduction band from the Cd concentration with increase in crystallite sizes from the XRD.
- Furthermore, repulsion effect between Cd 4d and O 2p levels in the valence band is a consequence of narrowing the optical band gap
- FTIR absorption peak around 465 $cm^{-1}$ assigned to Zn-O bond stretched at 513 $cm^{-1}$ and 903 $cm^{-1}$ due to the effect of Mg and Cd content with narrower peaks for CdMgZnO nanoparticles

Table 1. Analysis of crystallographic parameter of $Cd_xMg_{(0.12-x)}Zn_{0.88}O$ ($0.000 \leq x \leq 0.020$) nanoparticles, crystallites sizes (Scherrer´s and W-H method) and strain

| Con. of $Cd^{2+}$(x) at. % | d spacing (Å) | | | Lattice parameters | | Ratio | Cell volume | Crystal size (nm) Scherrer's | W - H | Strain |
|---|---|---|---|---|---|---|---|---|---|---|
| | (100) | (002) | (101) | a = b (Å) | c (Å) | c /a | (V)Å$^3$ | method | plot | ($\varepsilon \times 10^{-3}$) |
| 0.00 | 2.8078 | 2.5913 | 2.4688 | 3.2421 | 5.1827 | 1.5985 | 47.1792 | 20.06 | 20.68 | 1.60 |
| 0.004 | 2.8079 | 2.5921 | 2.4698 | 3.2422 | 5.1841 | 1.5989 | 47.1907 | 20.15 | 21.06 | 1.44 |
| 0.008 | 2.8082 | 2.5929 | 2.4700 | 3.2425 | 5.1859 | 1.5993 | 47.2163 | 20.20 | 21.56 | 1.12 |
| 0.012 | 2.8116 | 2.5967 | 2.4723 | 3.2461 | 5.1939 | 1.6000 | 47.3680 | 20.46 | 22.61 | 1.01 |
| 0.016 | 2.8127 | 2.5993 | 2.4732 | 3.2474 | 5.1976 | 1.6005 | 47.4679 | 20.65 | 23.81 | 0.83 |
| 0.020 | 2.8128 | 2.5999 | 2.4738 | 3.2479 | 5.1984 | 1.6005 | 47.4889 | 21.11 | 26.15 | 0.53 |

## ❖ CONCLUSION

**In this study the dependent of features devices on the properties of nanomaterials with the substitution of divalent metals (Cd and Mg) into ZnO is an effective route for improving and modifying the optical band gap and can be considered as a material for near UV and blue optoelectronic application which is confirmed from the decreased in optical band gap which varied from 3.30 eV to 2.92 eV with particle size increase and preservation of the crystal symmetry of the hexagonal wurtzite structure.**

**REFERENCES**
**[1]** O. Kalu, J. A. D. Moller, A. R. Rojas, **Structural and optical properties of cadmium magnesium zinc oxide (CdMgZnO) nanoparticles synthesized by sol-gel method,** Phys. Lett. A, 383(10) (2019) 1037-1046. https://doi.org/10.1016/j.physleta.2018.11.0
**[2]** L.T. Jule, F.B. Dejene, A.G. Ali, K.T. Roro, A. Hegazy, N. K. Allam, E.E. Shenawy **Wide visible emission and narrowing band gap in Cd-doped ZnO nanopowders synthesized via sol-gel route,** J. Alloys compds. 687 (2016) 920-926.

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**[1]** O. Kalu, J. A. D. Moller, A. R. Rojas, **Structural and optical properties of cadmium magnesium zinc oxide (CdMgZnO) nanoparticles synthesized by sol-gel method,** Phys. Lett. A, 383(10) (2019) 1037-1046. https://doi.org/10.1016/j.physleta.2018.11.0