Electronic Supplementary Material (ESI) for RSC Advances.

Additive-free 1,4-butanediol mediated synthesis: a suitable route to obtain nanostructured, mesoporous spherical zinc oxide materials with multifunctional properties

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Electronic Supplementary Information
(ESI)

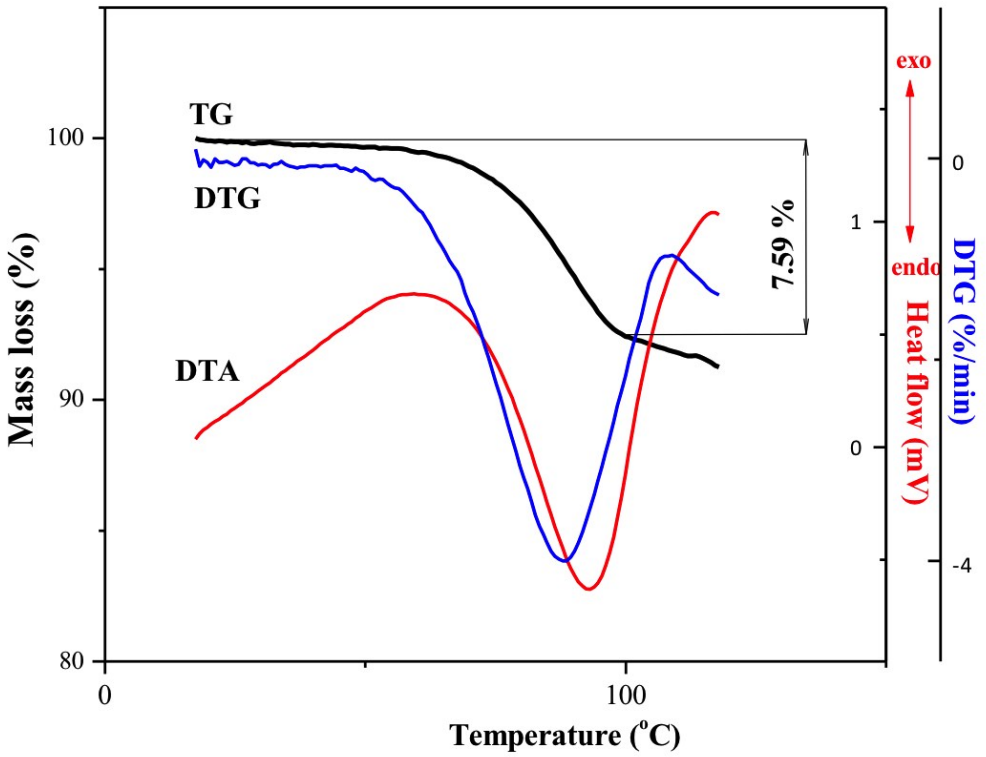


Figure S1. Thermal curves (TG, DTG and DTA) for $Zn(acac)_2 \cdot 1.2\ H_2O$ dehydration

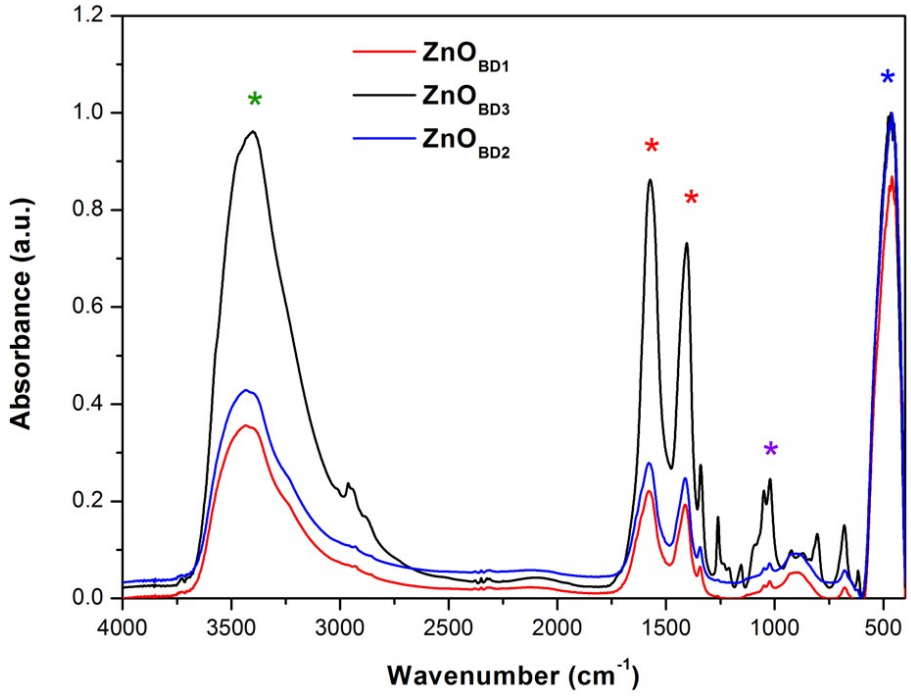


Figure S2. FTIR spectra for **ZnO_{BD1}-ZnO_{BD3}** series of zinc oxide samples: * - zinc oxide, * - $\nu(C{=}O)_{acetylacetonate}$, and * - $\nu(C\text{-}C)_{BD}$; * - ν(O-H) from water and/or layered hydroxide zinc(II) acetylacetonate.

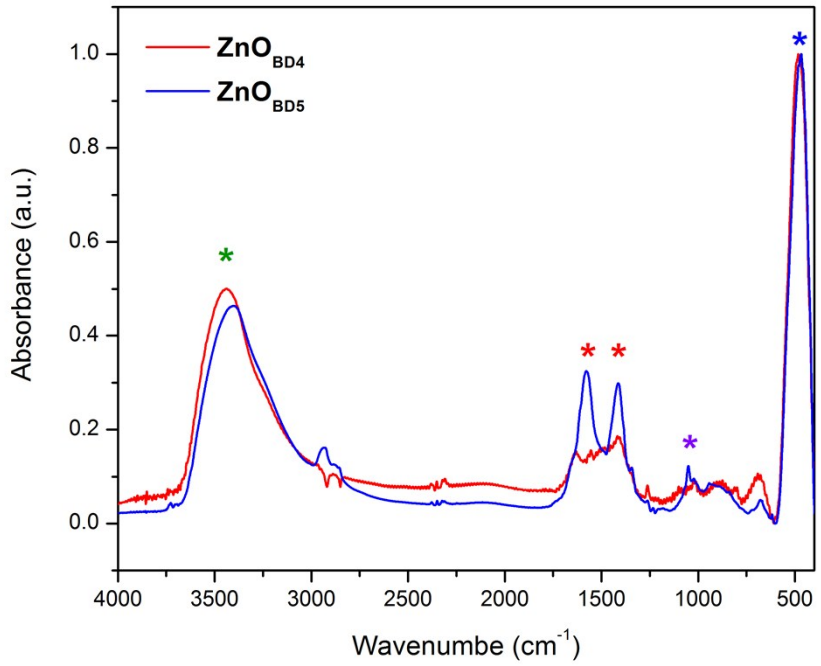


Figure S3. FTIR spectra for **ZnO_{BD4}** and **ZnO_{BD5}** samples: * - zinc oxide, * - $\nu(C=O)_{acetylacetonate}$, and * - $\nu(C-C)_{BD}$; * - ν(O-H) from water and/or hydroxide zinc(II) acetylacetonate.

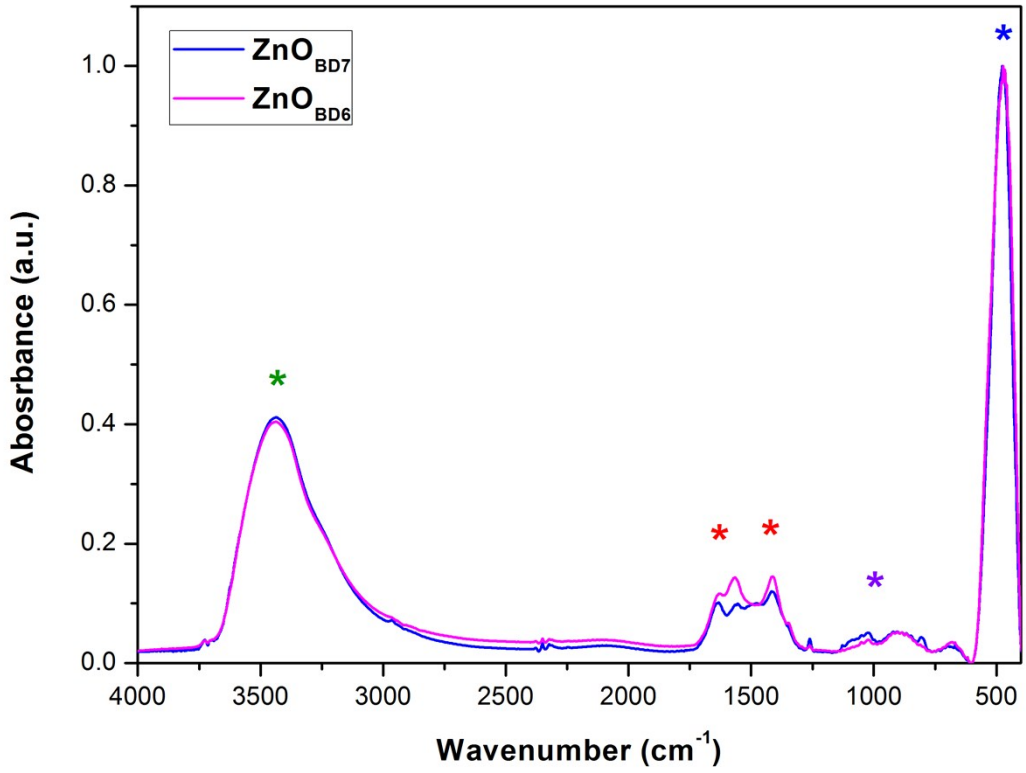


Figure S4. FTIR spectra for **ZnO_{BD6}** and **ZnO_{BD7}** samples: * - zinc oxide, * - $\nu(C=O)_{acetylacetonate}$, and * - $\nu(C-C)_{BD}$; * - ν(O-H) from water and/or hydroxide zinc(II) acetylacetonate.

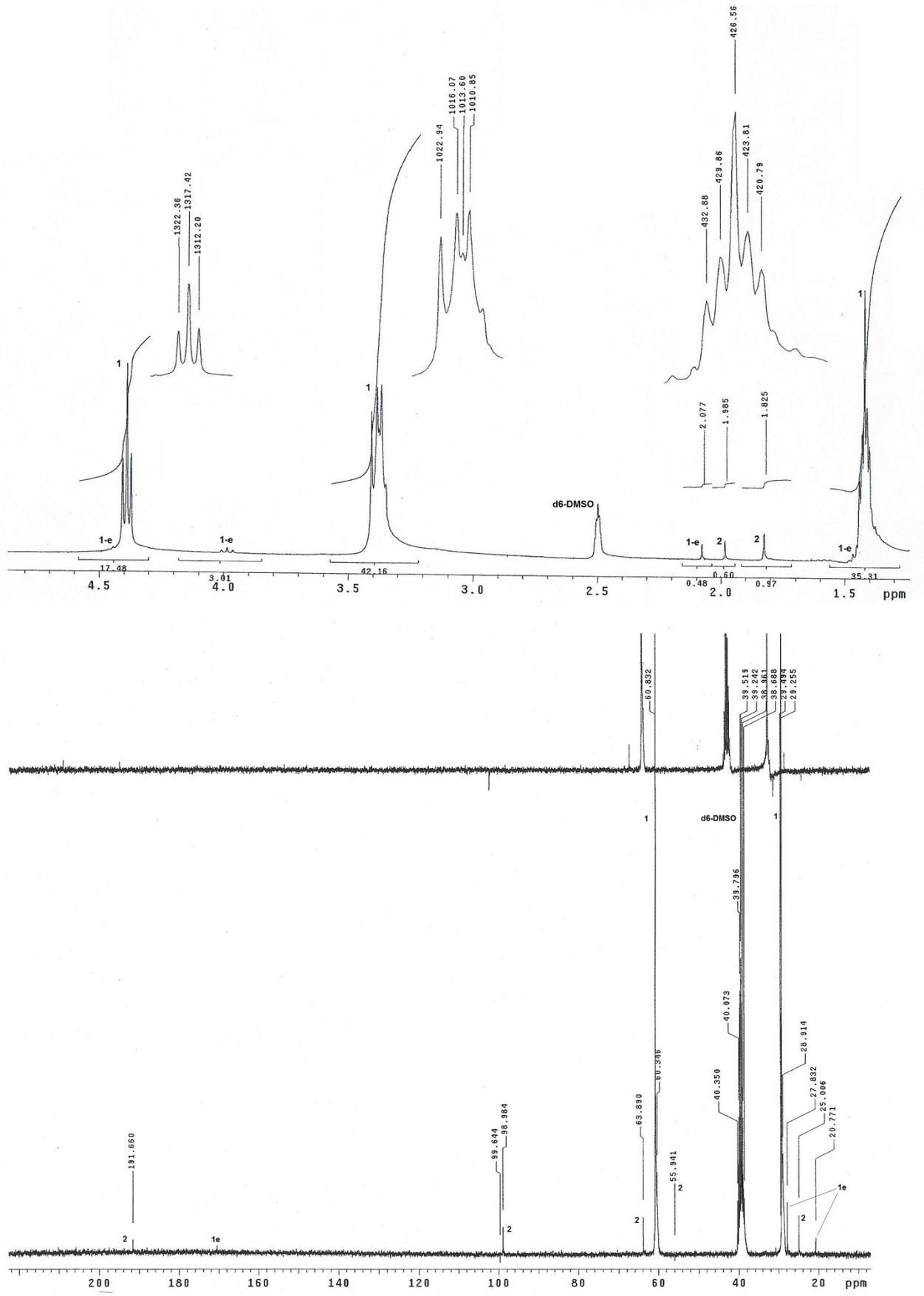


Figure S5. ^{1}H NMR (top) and ^{13}C NMR (bottom) spectrum for the supernatant solution obtained after the precipitation of $\mathbf{ZnO_{BD2}}$ oxide: **1** – 1,4-butanediol specific signals, **1-e** – traces of BD-ester, **2** –acetylacetonate specific signals.

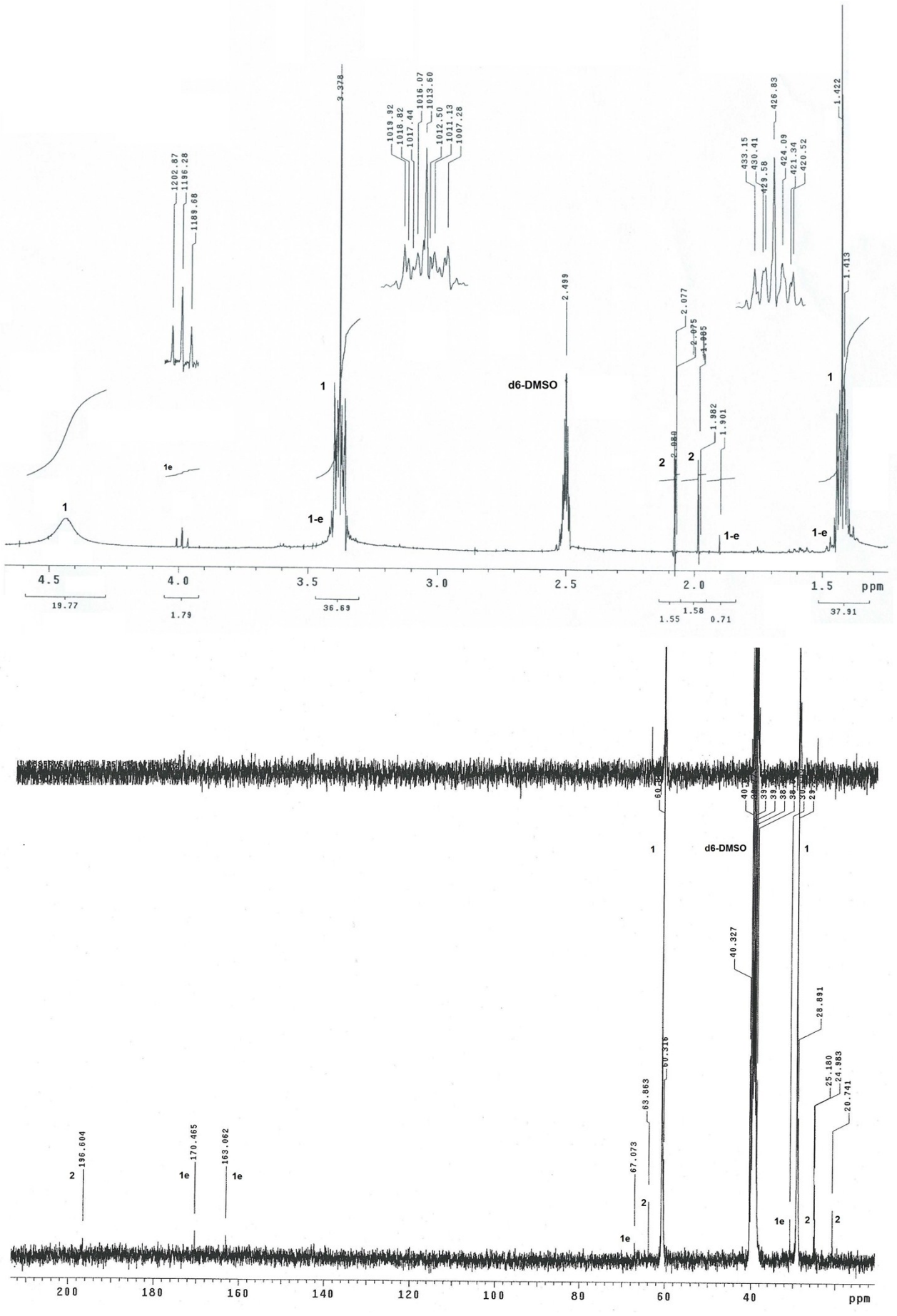


Figure S6. ^{1}H NMR (top) and ^{13}C NMR (bottom) spectrum for supernatant solution obtained after the $\mathbf{ZnO_{BD7}}$ precipitation: **1** – 1,4-butanediol specific signals, **1-e** – traces of BD-ester, **2** –acetylacetonate specific signals.

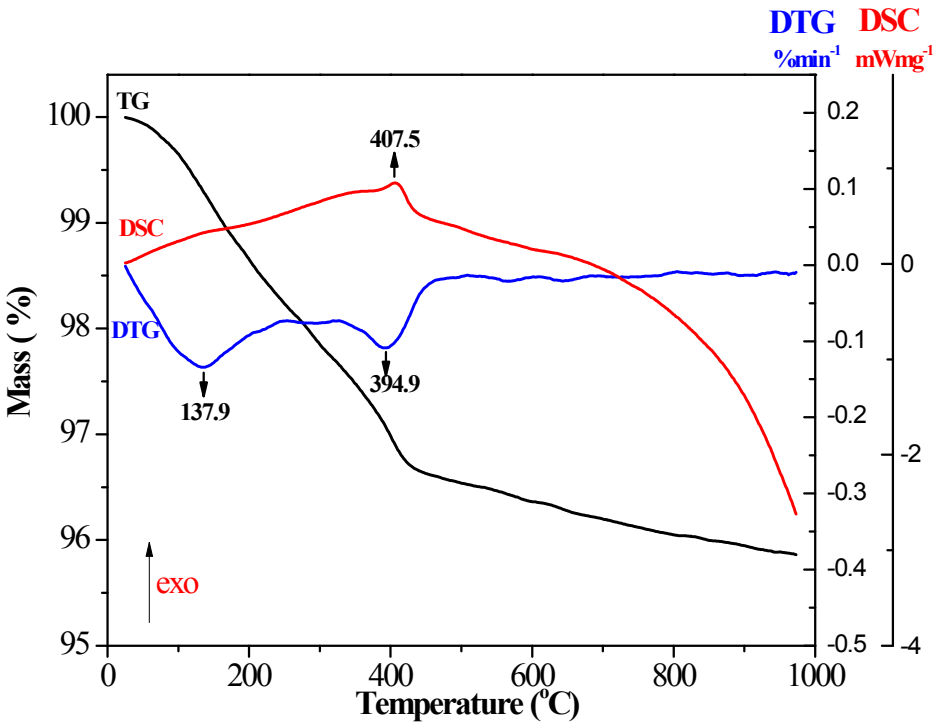


Figure S7. Thermal curves (TG, DTG and DSC) of **ZnO_{BD7}** sample.

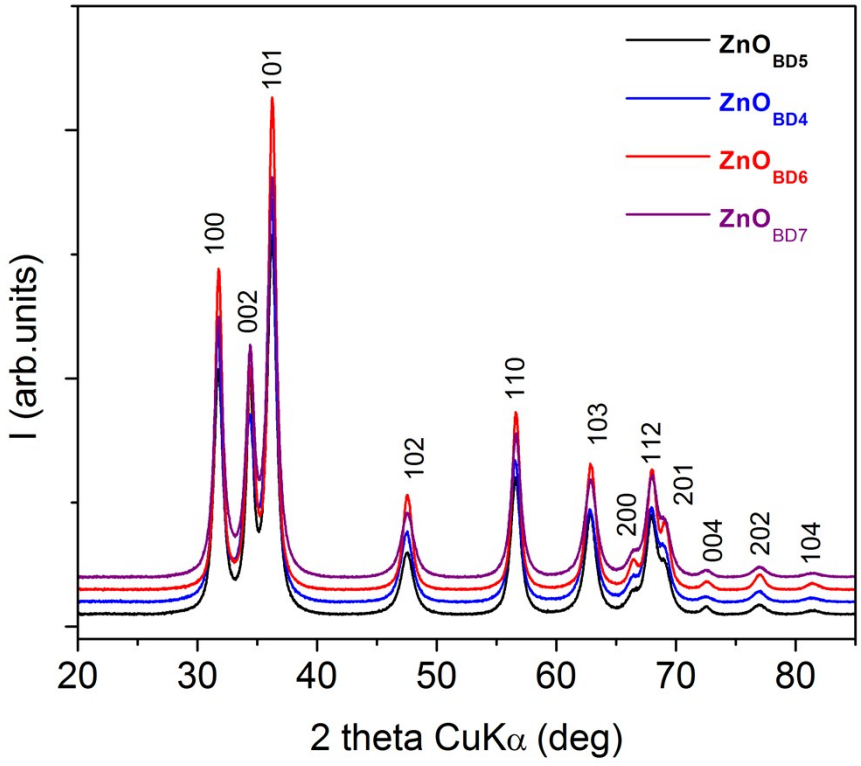


Figure S8. The XRD diffractograms recorded for **ZnO_{BD4}-ZnO_{BD7}** group of samples

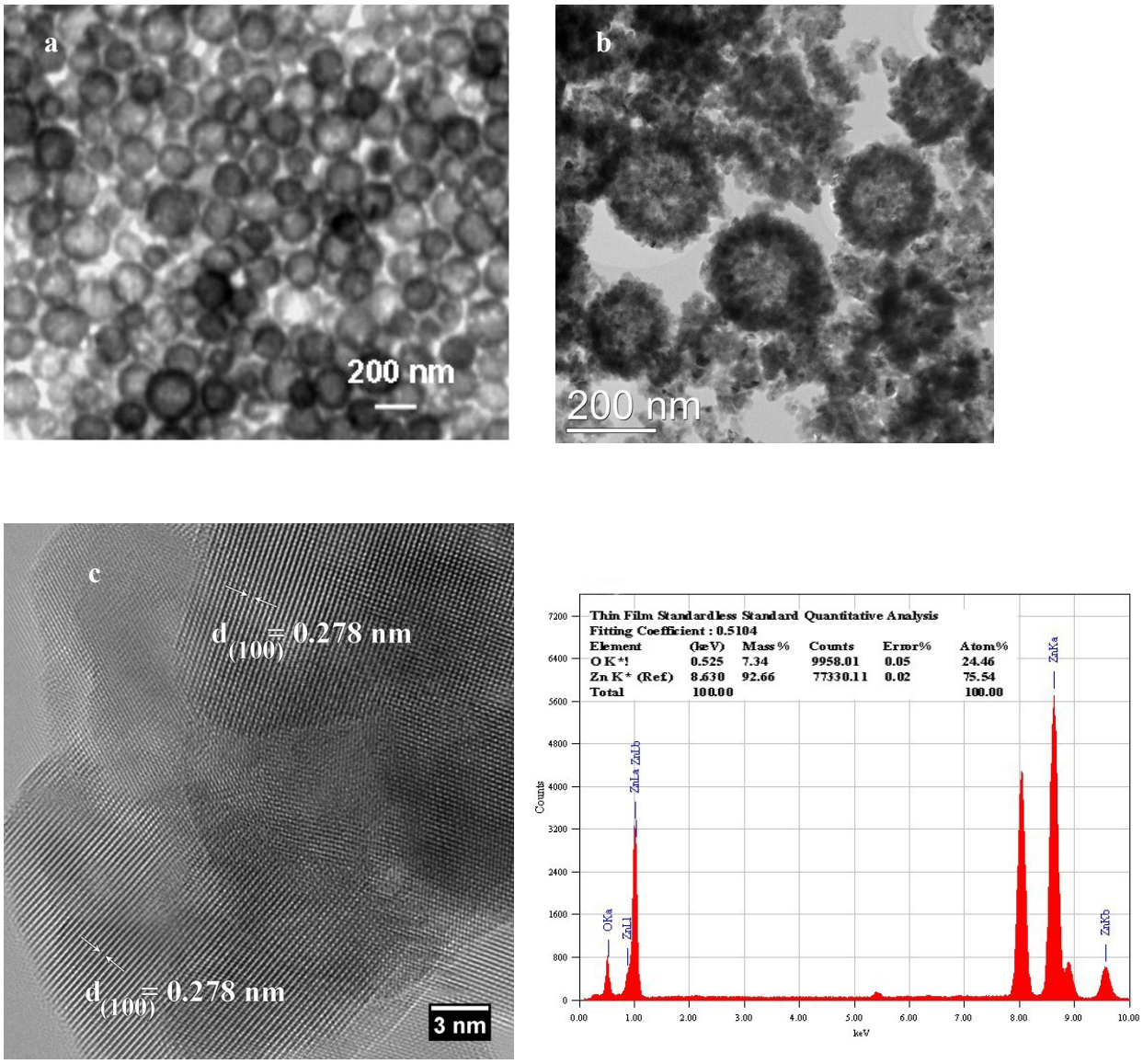


Figure S9. (a) SEM panoramic micrograph; (b) TEM micrograph; (c) HRTEM image and (e) EDS analysis for **ZnO_{BD1}** oxide.

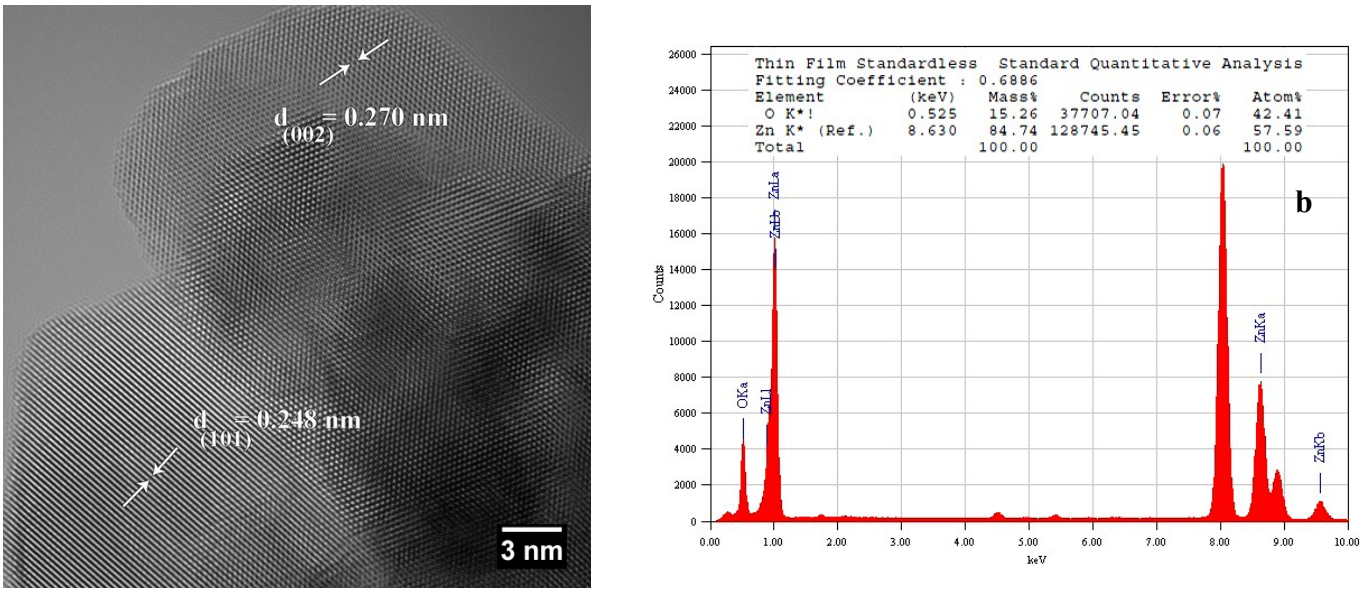


Figure S10. (a) HRTEM image and (b) EDS analysis of **ZnO_{BD2}** product.

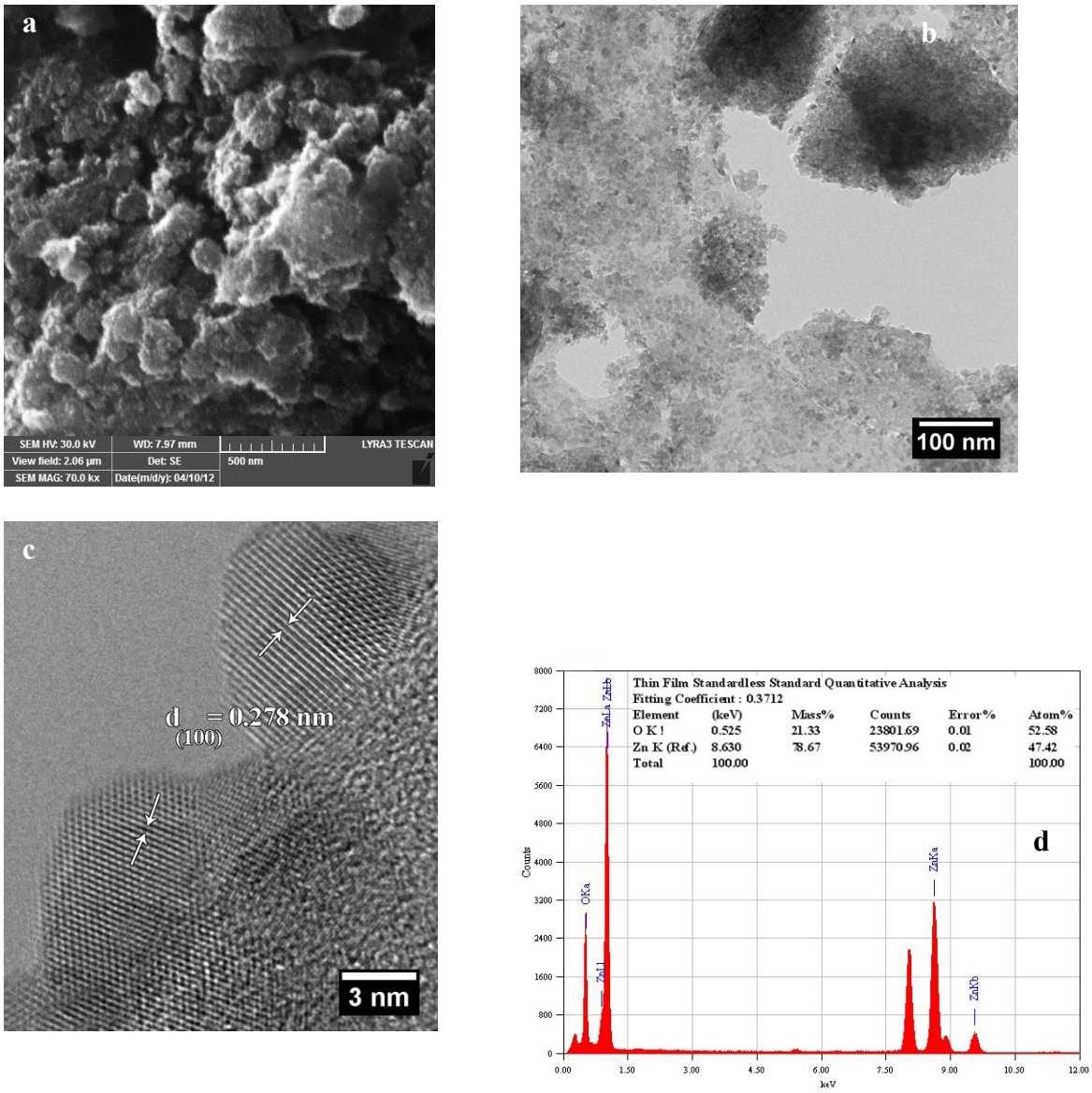


Figure S11. (a) SEM panoramic micrograph, (b) TEM micrograph at higher magnification (c) HRTEM image and (d) EDS analysis for **ZnO_{BD3}** product.

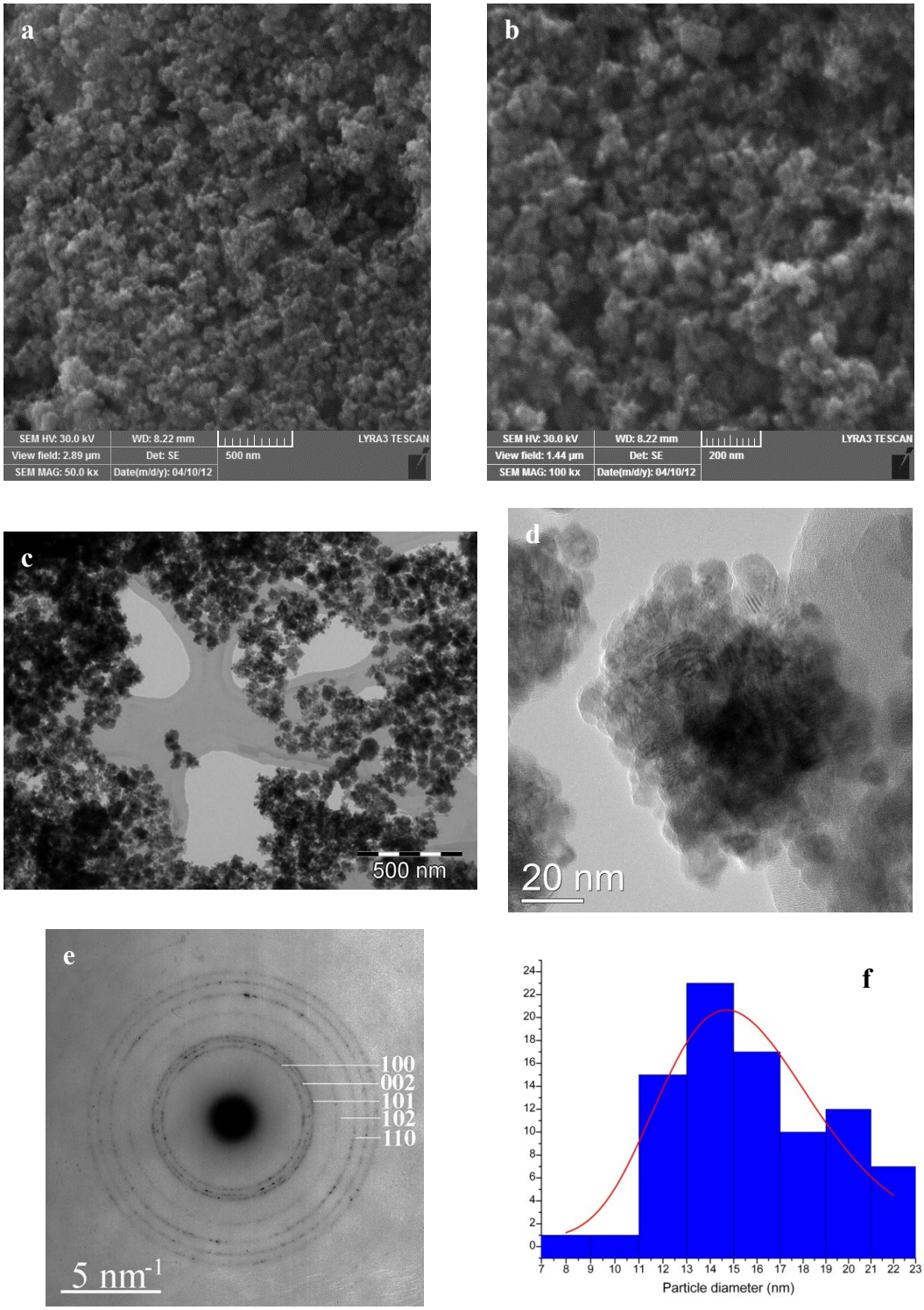


Figure S12. (a) SEM panoramic micrograph; (b) SEM panoramic micrograph at higher maginifcation; (c) TEM micrograph; (d) magnified TEM image; (e) SAED pattern and (f) particles size distribution for **ZnO_{BD5}** oxide.

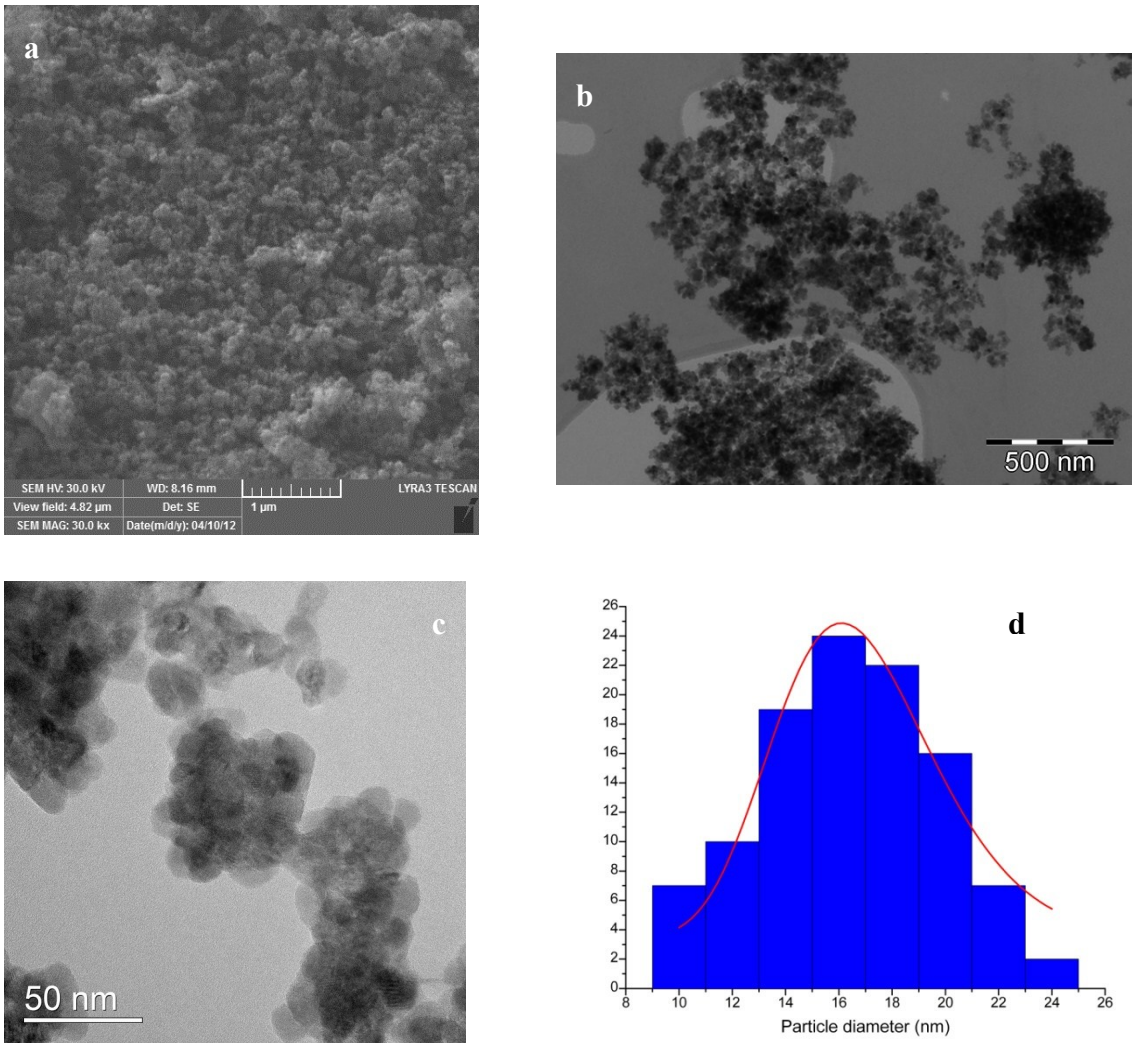


Figure S13. (a) SEM panoramic micrograph; (b) TEM micrograph; (c) magnified TEM image and (d) particles size distribution for $\mathbf{ZnO_{BD6}}$ oxide.

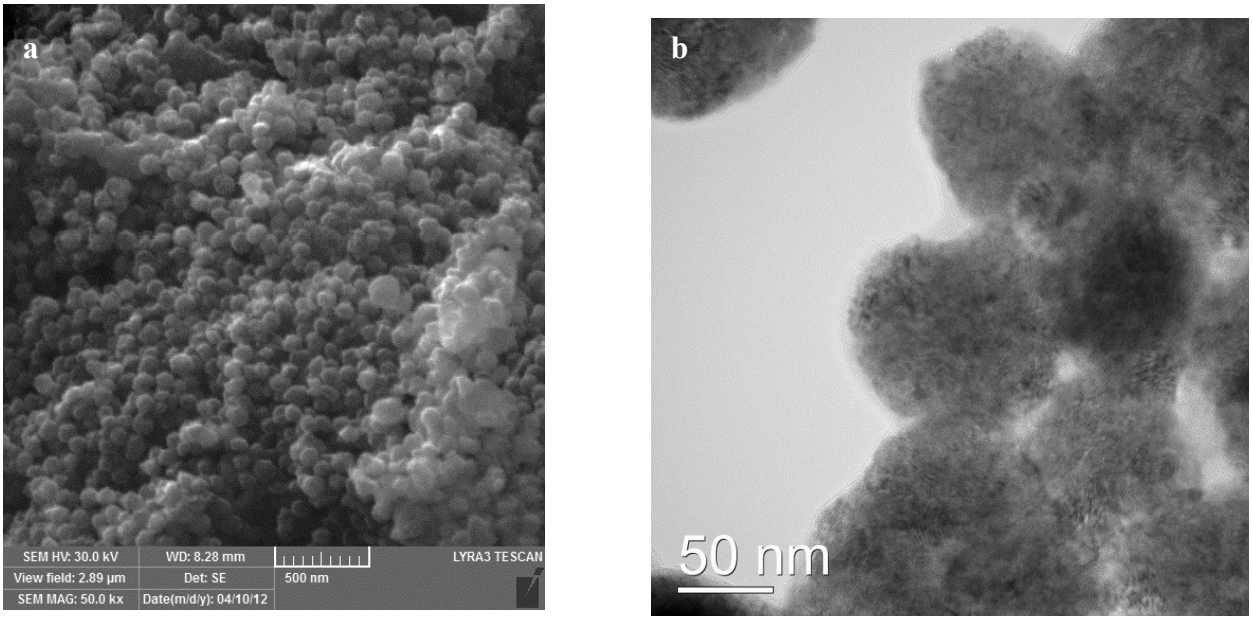


Figure S14. (a) SEM panoramic micrograph and (b) TEM micrograph for **ZnO_{BD7}** oxide.

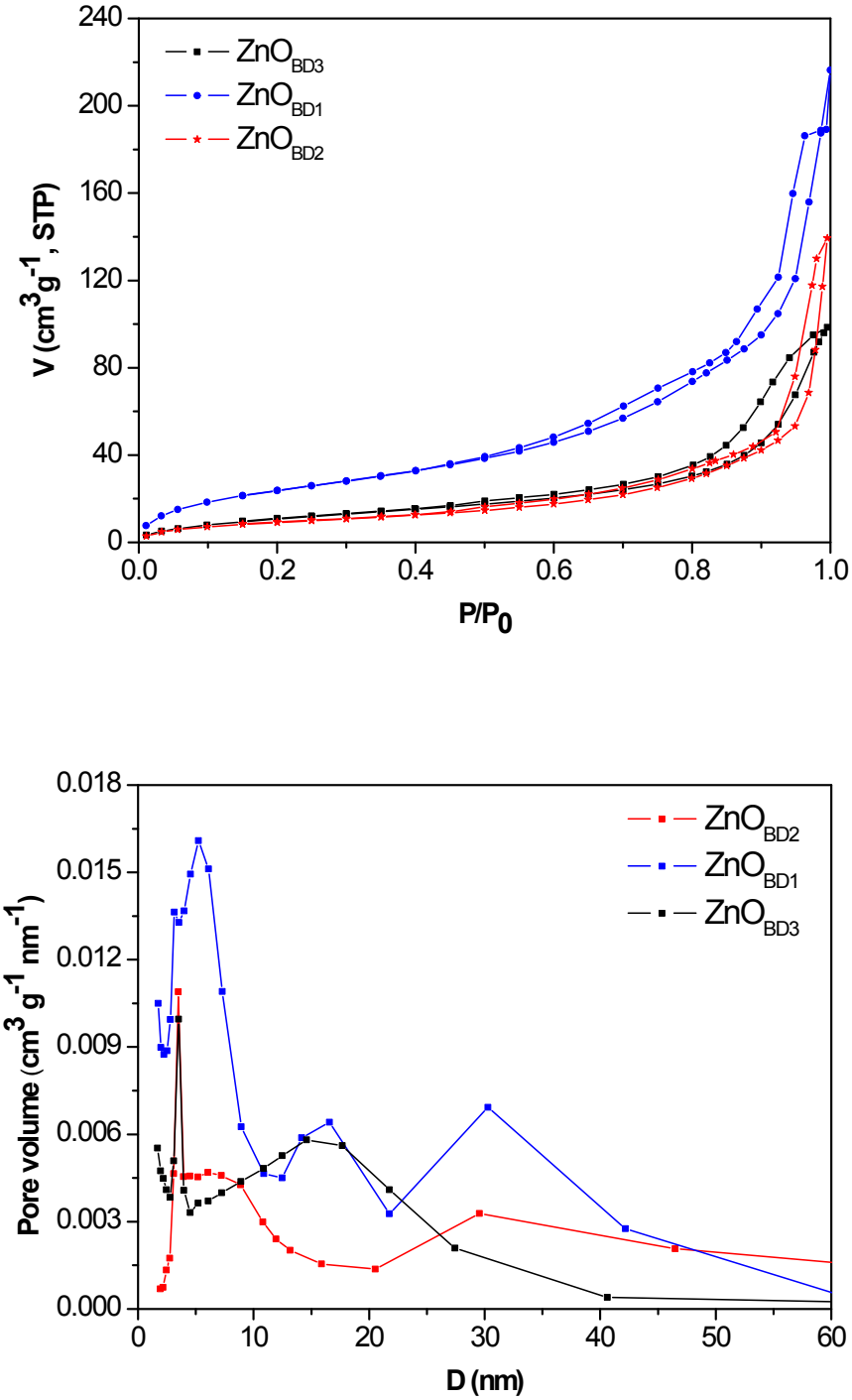


Figure S15. N_2 adsorption–desorption isotherms (top) and pore size distribution (bottom) of **ZnO$_{BD1}$** – **ZnO$_{BD3}$** samples

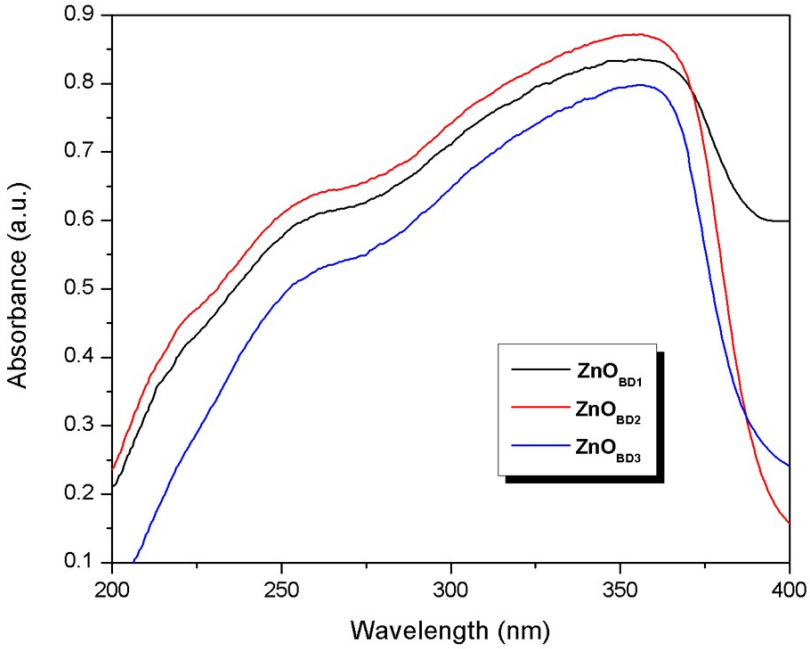


Figure S16. UV-Vis spectra for **ZnO_{BD1}-ZnO_{BD3}** group of oxides.

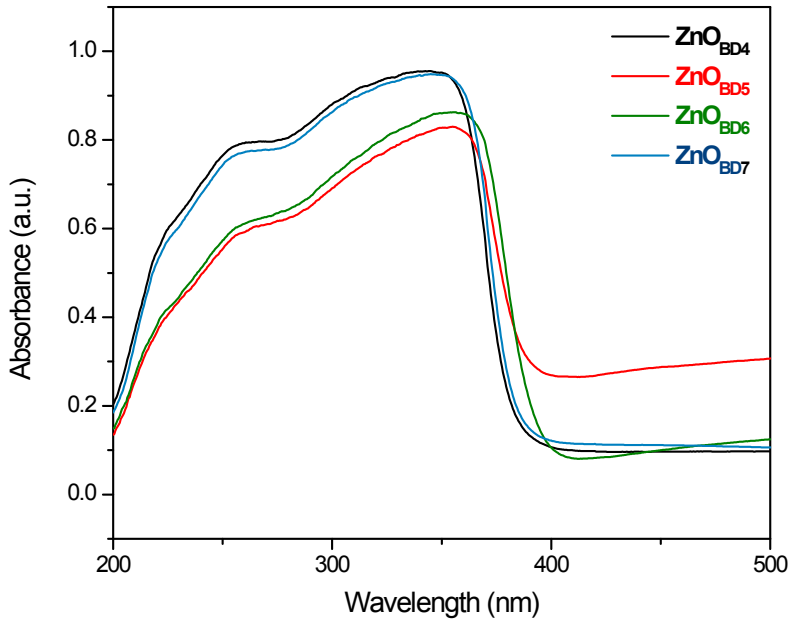


Figure S17. UV-Vis spectra for **ZnO_{BD4}-ZnO_{BD7}** group of oxides.

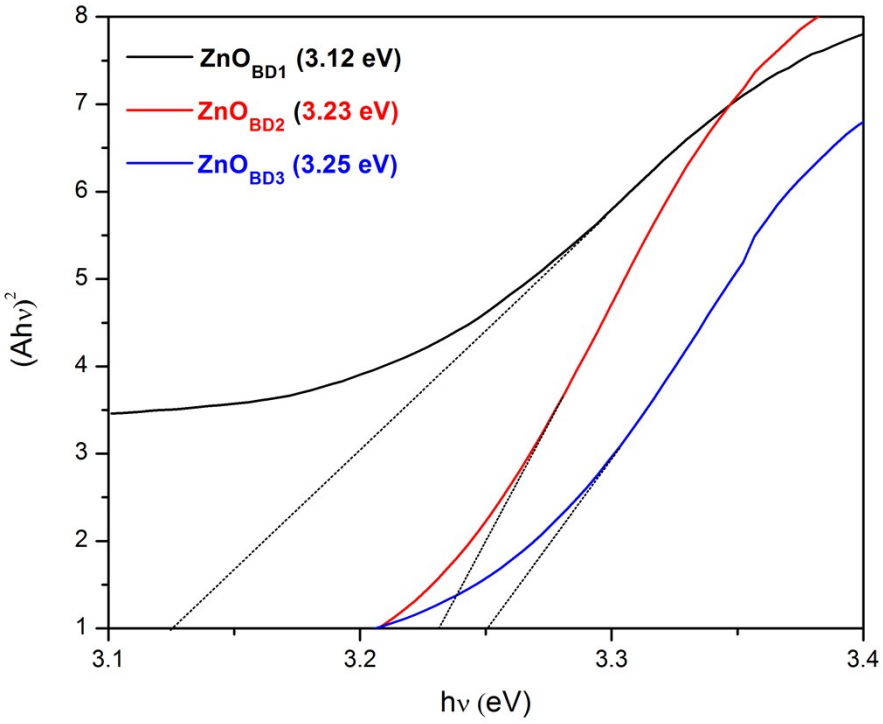


Figure S18. (Ahν)^2 vs. hν plot for determining absorption onset for **ZnO$_{BD1}$-ZnO$_{BD3}$** group of oxides.

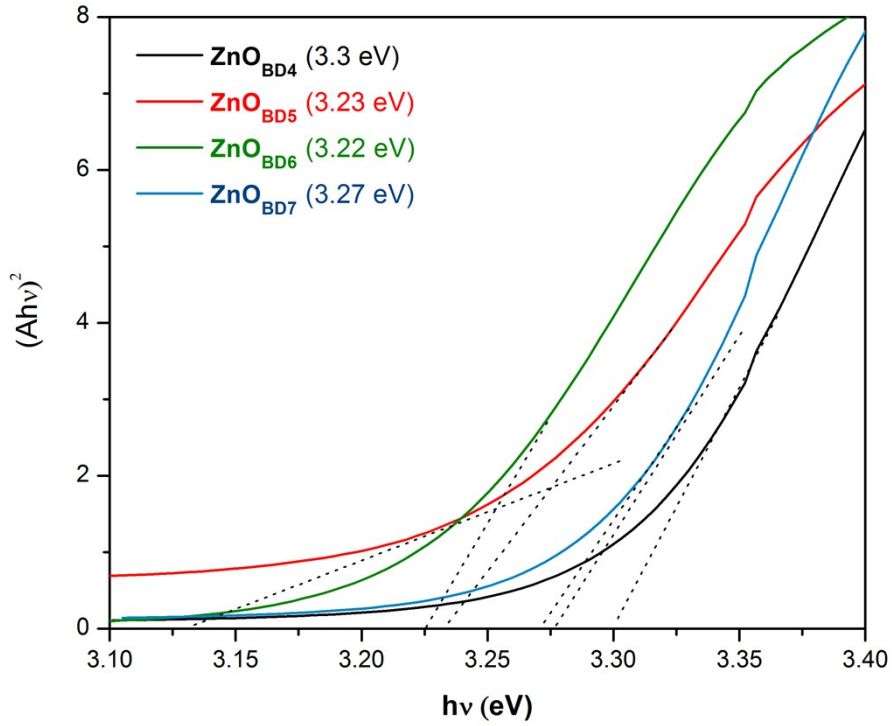


Figure S19. (Ahν)^2 vs. hν plot for determining absorption onset for **ZnO$_{BD4}$-ZnO$_{BD7}$** group of oxides.

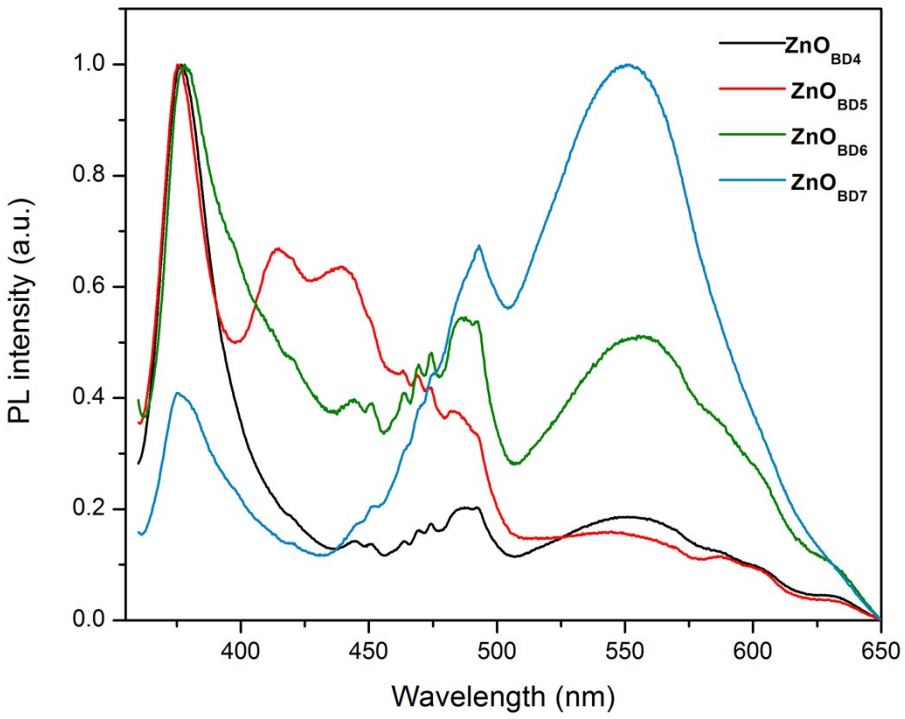


Figure S20. Room-temperature emission PL spectra for **ZnO_{BD4}-ZnO_{BD7}** samples

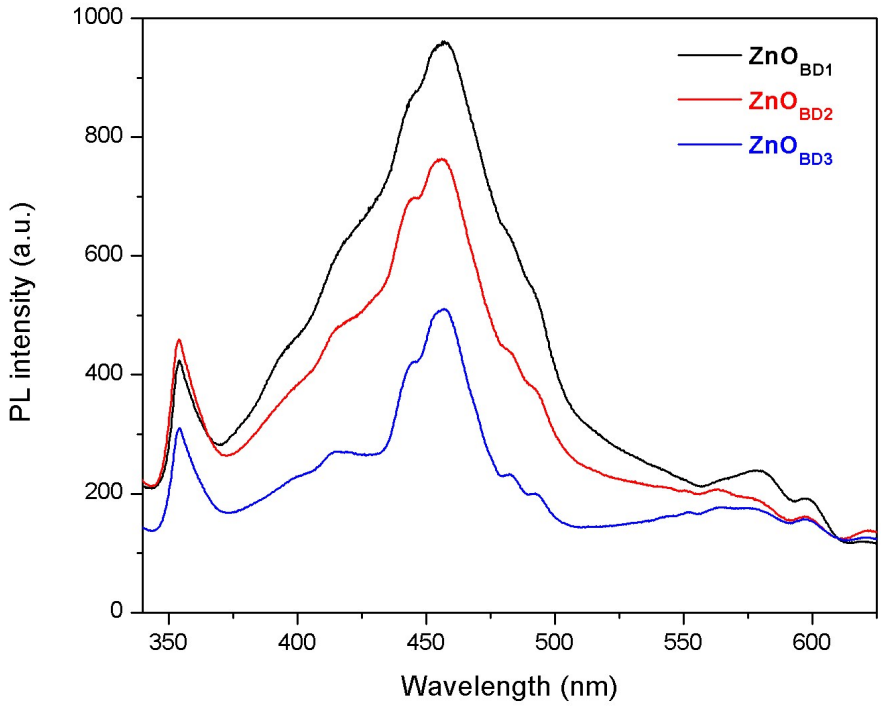


Figure S21. Room-temperature emission PL spectra for **ZnO_{BD1}-ZnO_{BD3}** samples, calcined at 500°C for 1h.

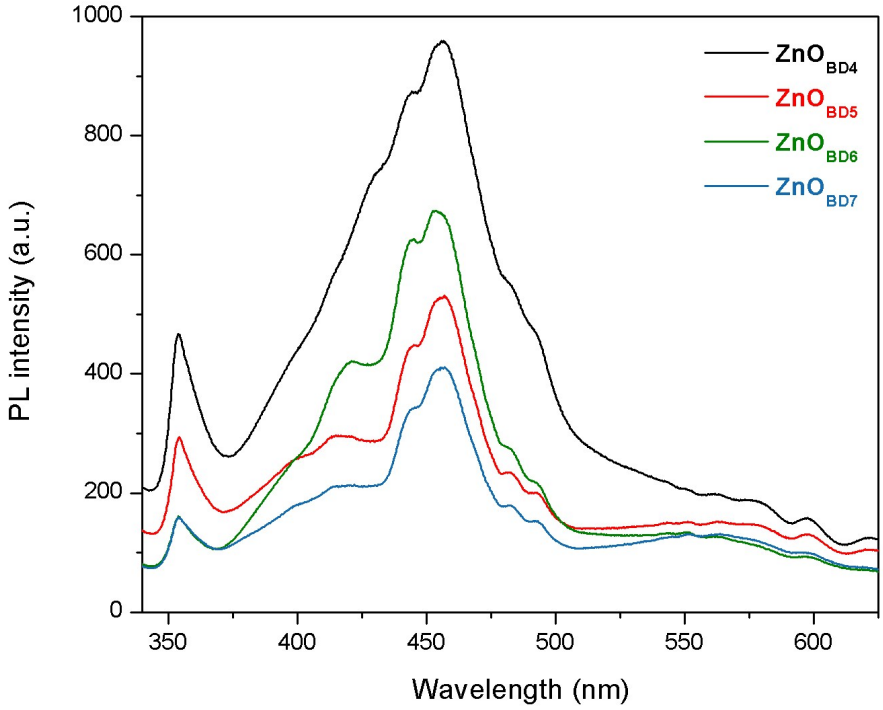
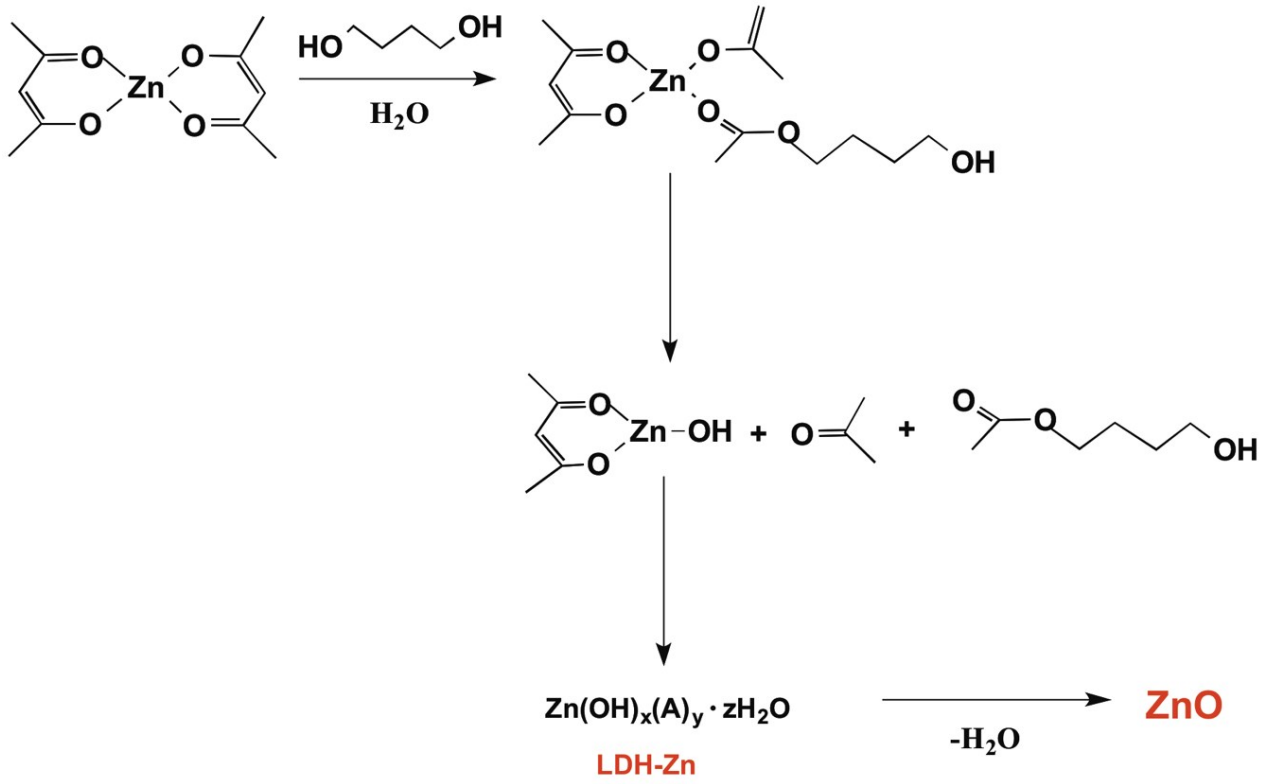


Figure S22. Room-temperature emission PL spectra for **ZnO_{BD1}-ZnO_{BD3}** samples, calcined at 500°C for 1h.



Scheme S1. Proposed reaction pathway for the formation of zinc oxide in BD-assisted synthesis.

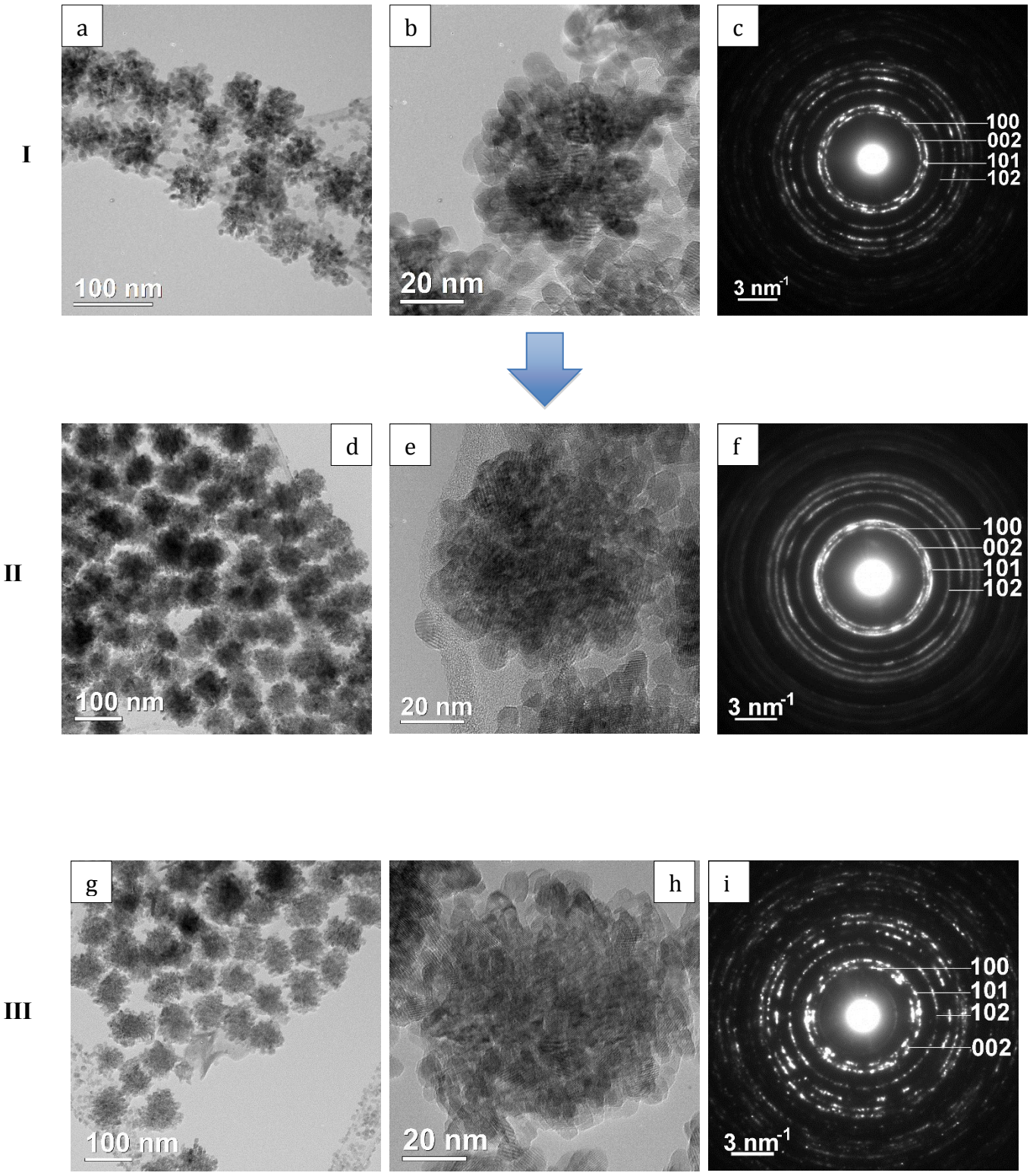


Figure S23. TEM image at low magnification

(a, d, g), xHRTEM micrographs centered on a particle of ZnO formed by small crystallites (b, e, h) and SAED patterns (c, f, i) for samples obtained at 0.25 M zinc cations concentration, at 140^{o}C after 45 (**I**), 90 (**II**) and 180 minutes (**III**).

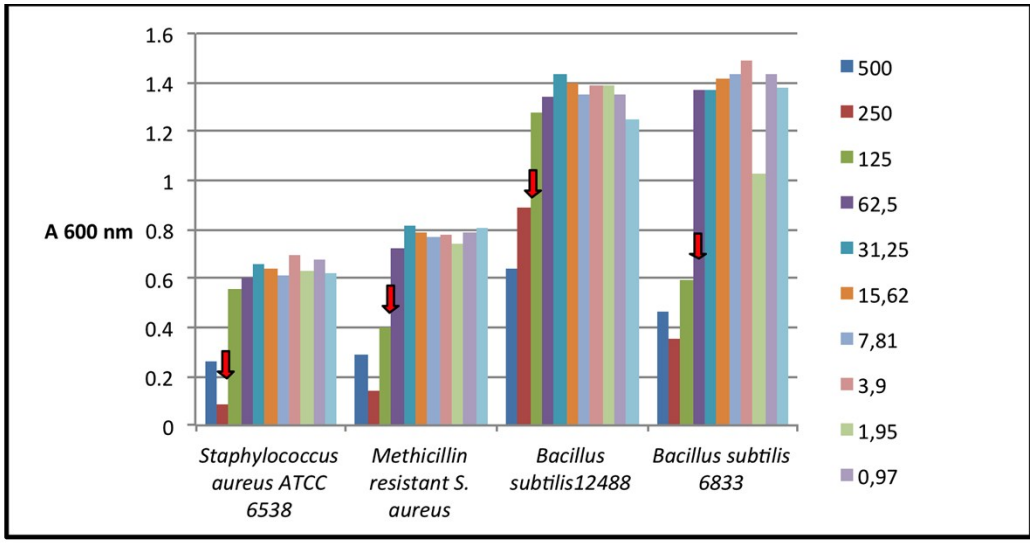


Figure S24. Graphic representation of the level of Gram-positive microbial strains growth quantified by measuring the absorbance of liquid cultures at 600 nm in the presence of two-fold serial dilutions of the tested compound. MIC values are indicated by red arows.

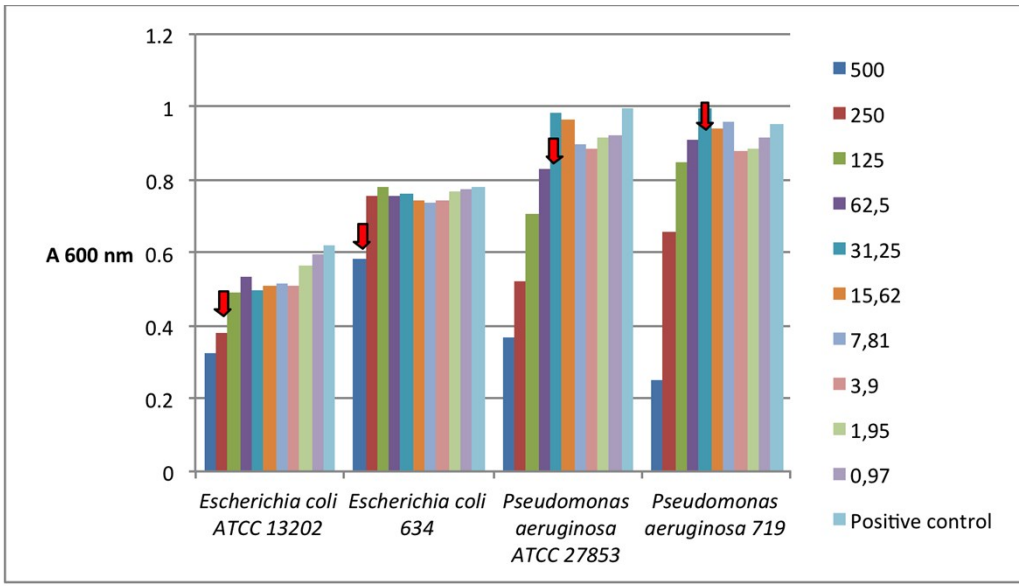


Figure S25. Graphic representation of the level of Gram-negative microbial strains growth quantified by measuring the absorbance of liquid cultures at 600 nm in the presence of two-fold serial dilutions of the tested compound. MIC values are indicated by red arows.

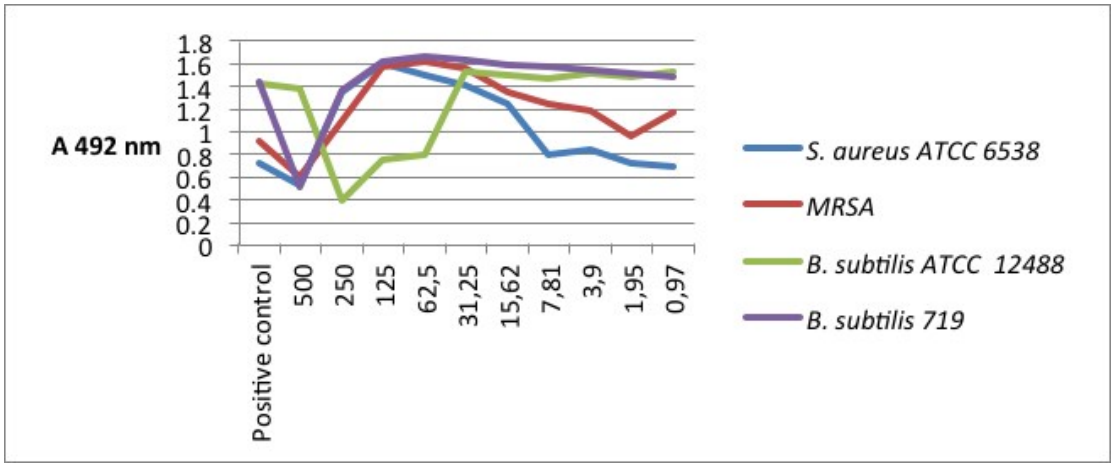


Figure S26. Graphic representation of the degree of microbial biofilms formed by the Gram-negative tested strains development in the presence of binary concentrations of the tested compound.

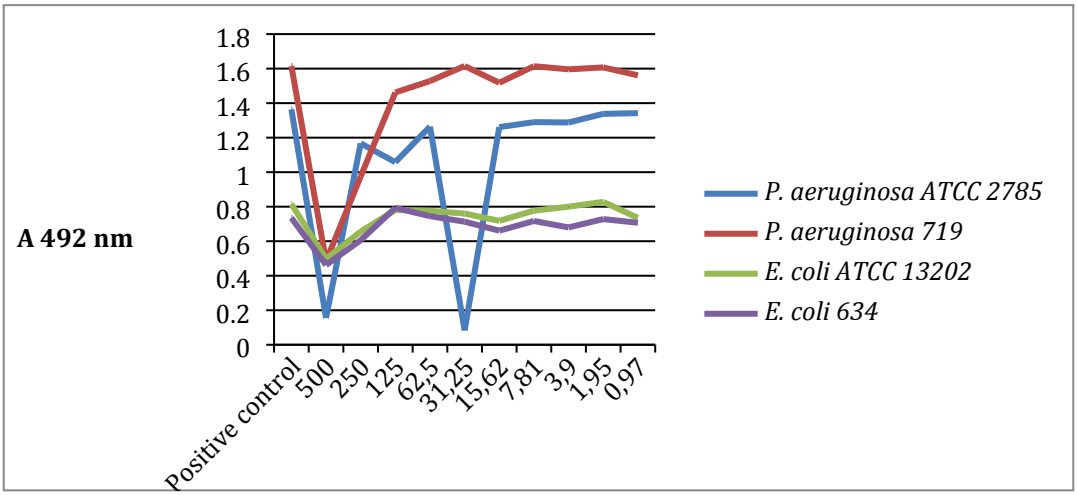


Figure S27. Graphic representation of the degree of microbial biofilms formed by the Gram-negative tested strains development in the presence of binary concentrations of the tested compound.

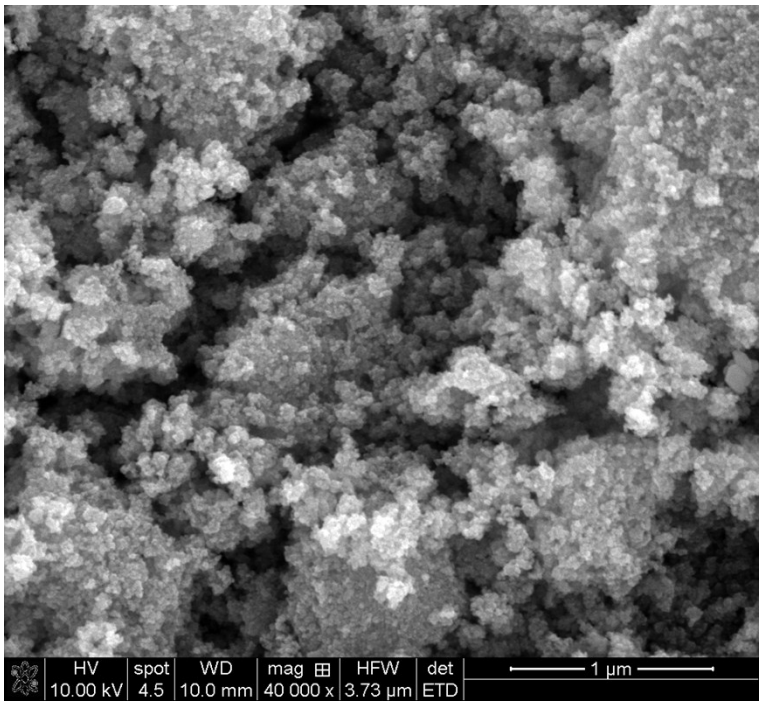


Figure S28. SEM panoramic micrograph for ZnO product obtained in 1,2-propanediol for 0.25 M zinc source concentration (140^{o}C for 2h).