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Supplementary information

A simple one-pot synthesis of $Zn(O,S)/Ga_2O_3$ nanocomposite photocatalyst for hydrogen production and 4-nitrophenol reduction.

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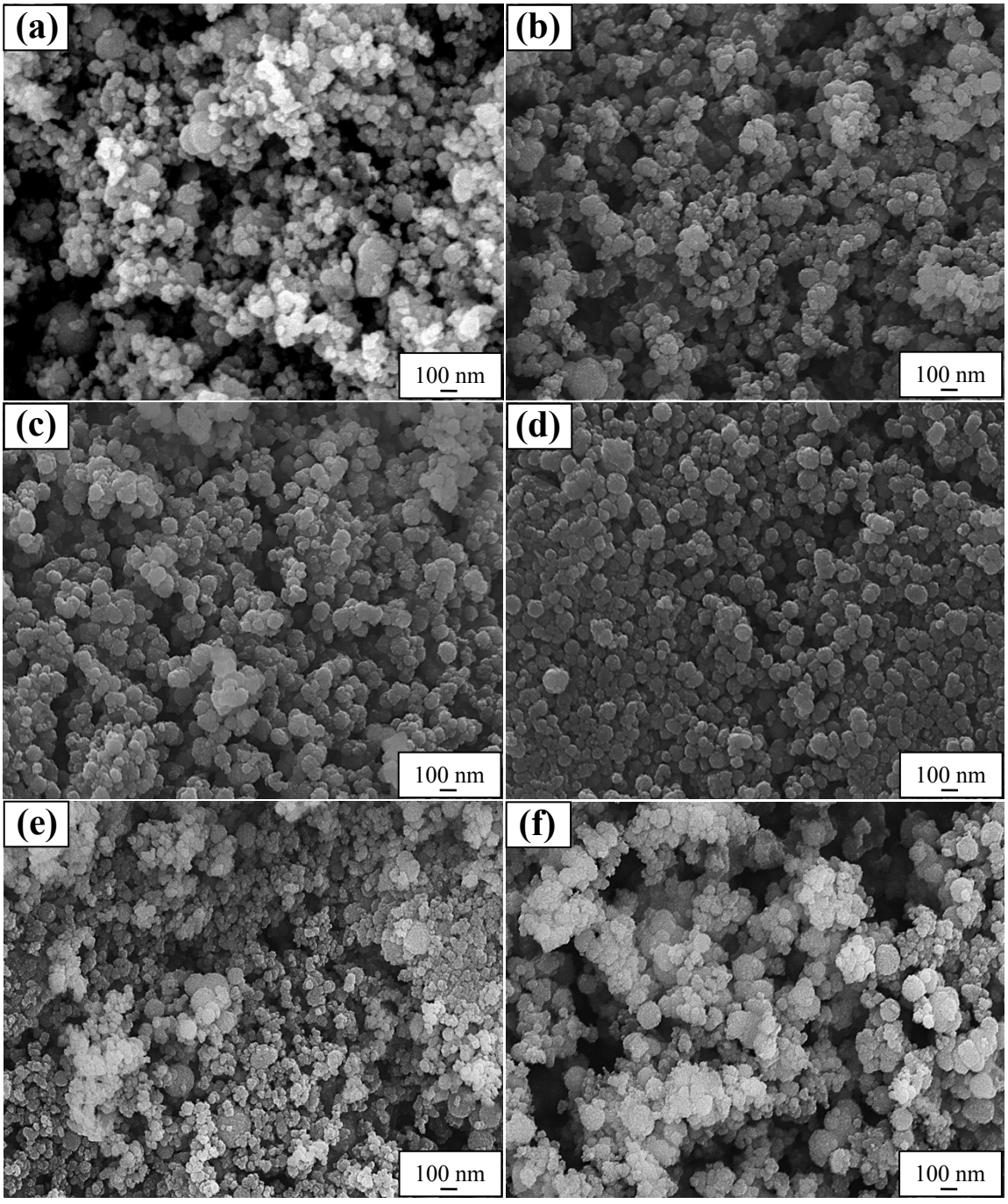

(a)
100 nm
(b)
100 nm
(c)
100 nm
(d)
100 nm
(e)
100 nm
(f)
100 nm

Fig. S1 FE SEM images of as-prepared $Zn(O,S)/Ga_2O_3$ nanocomposites with (a) 0%, (b) 0.5%, (c) 3%, (d) 5%, (e) 10% and (f) 20% Ga_2O_3 contents in the nanocomposites.

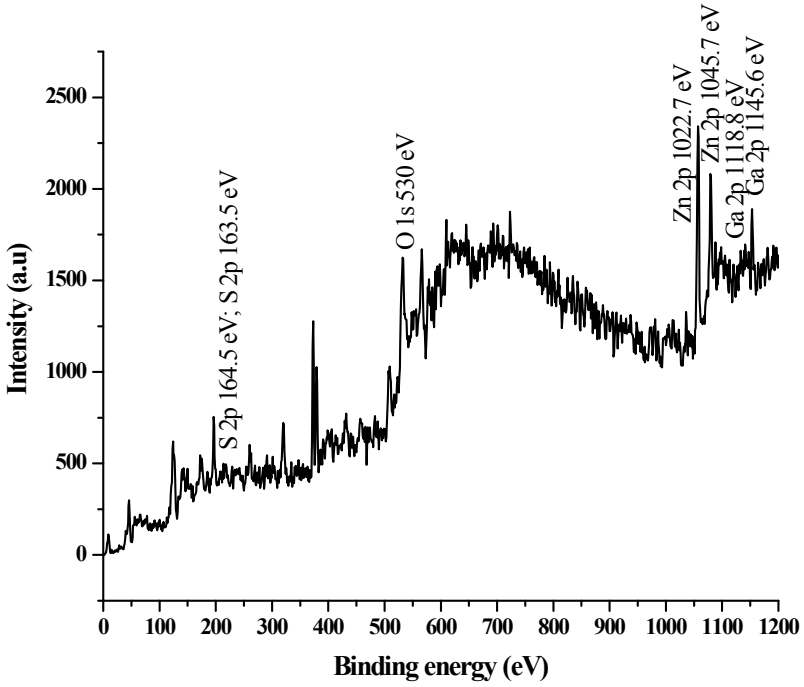
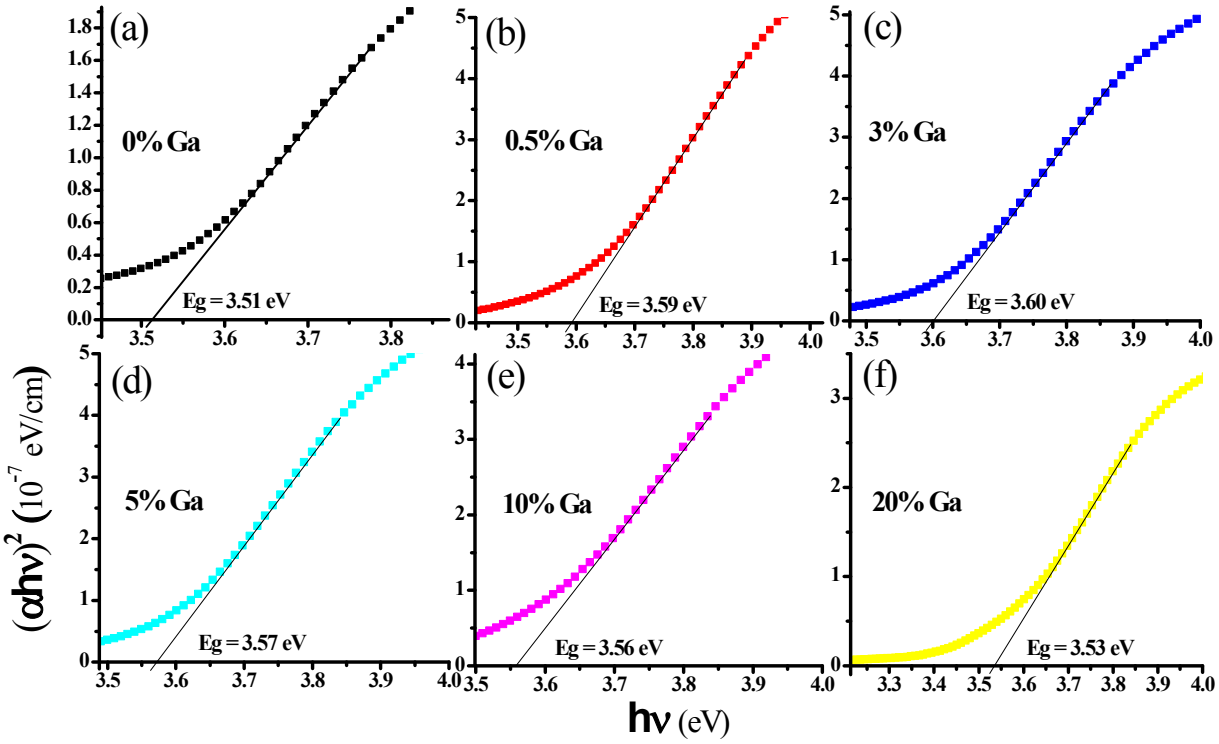


Fig. S2 Full scan XPS spectra of $Zn(O,S)/Ga_2O_3$ nanocomposites


(a)
0% Ga
Eg = 3.51 eV
(b)
0.5% Ga
Eg = 3.59 eV
(c)
3% Ga
Eg = 3.60 eV
(d)
5% Ga
Eg = 3.57 eV
(e)
10% Ga
Eg = 3.56 eV
(f)
20% Ga
Eg = 3.53 eV
(αhν)2 (10-7 eV/cm)
hν (eV)

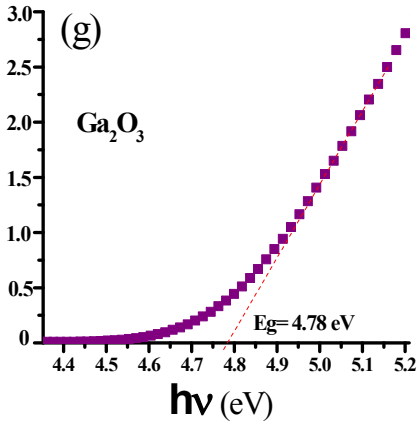

(g)
Ga2O3
Eg= 4.78 eV
hν (eV)

Fig. S3 Bandgap value determination of Zn(O,S)/Ga_2O_3 with different amounts of Ga_2O_3 and as-prepared Ga_2O_3

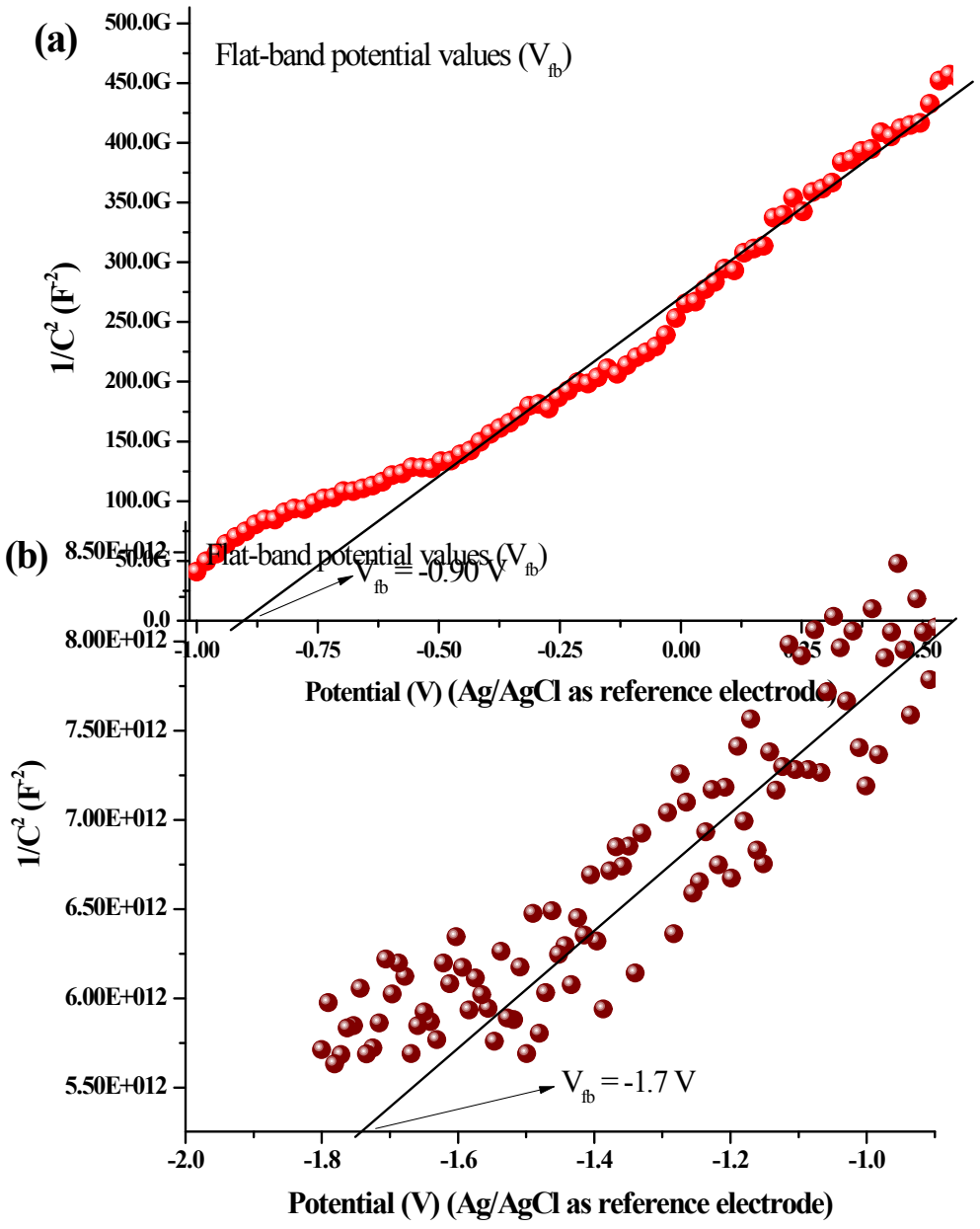


Fig. S4 Mott-Schottky plots of (a) Zn(O,S) and (b) Ga_2O_3 powders with the fitting line to determine the flat band potentials

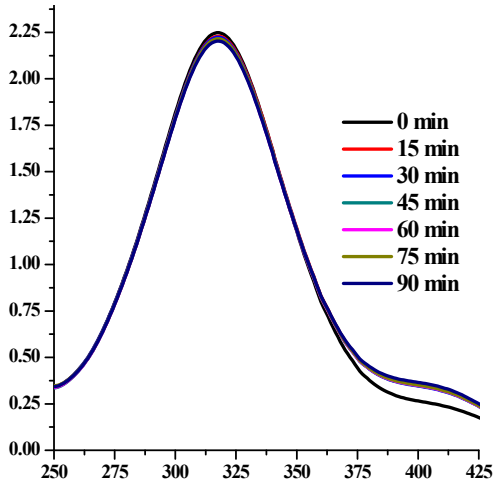


Fig. S5 UV-Vis absorbance spectra of (a) 30 ppm 4-NP + 10% ethanol solution with different 24 W UV-light illumination periods.

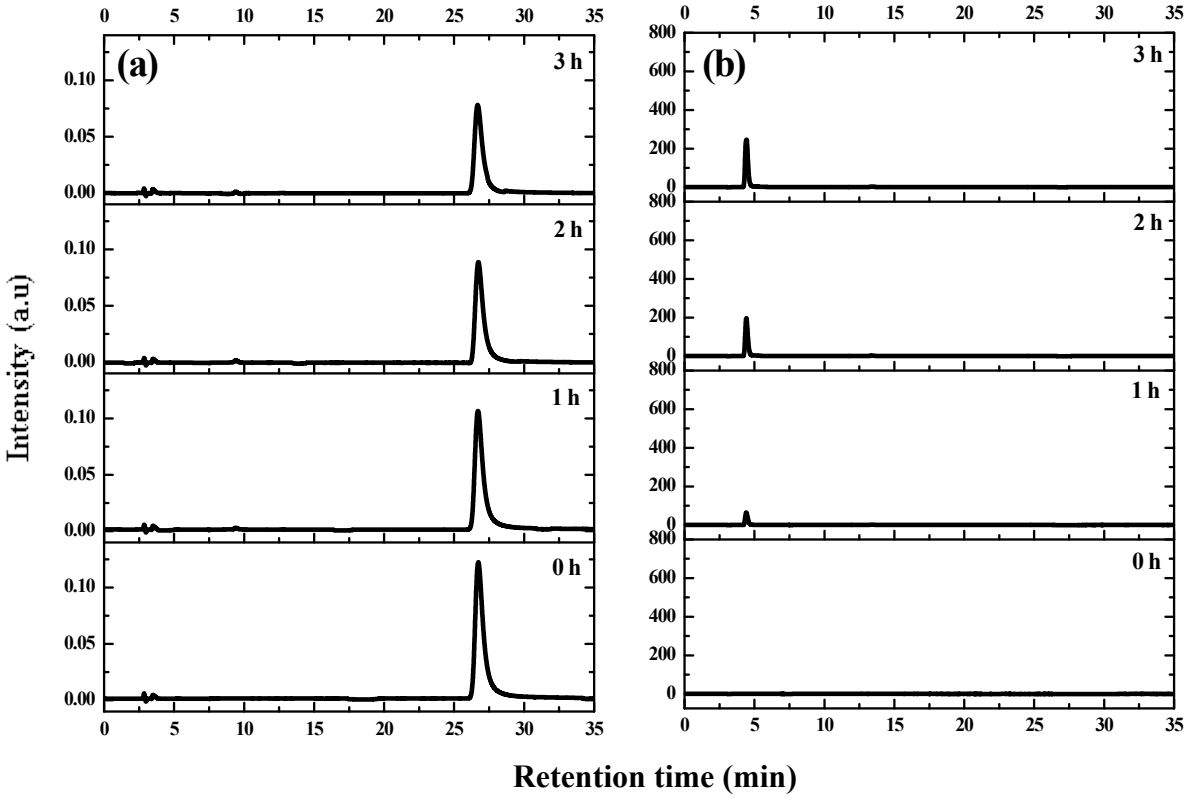


Fig. S6 High performance liquid chromatograms (HPLC) of (a) 4-NP and (b) 4-AP solutions after photocatalytic reduction reaction in the presence of Zn(O,S) nanoparticles with different photo reaction times using UV and fluorescence detectors, respectively.

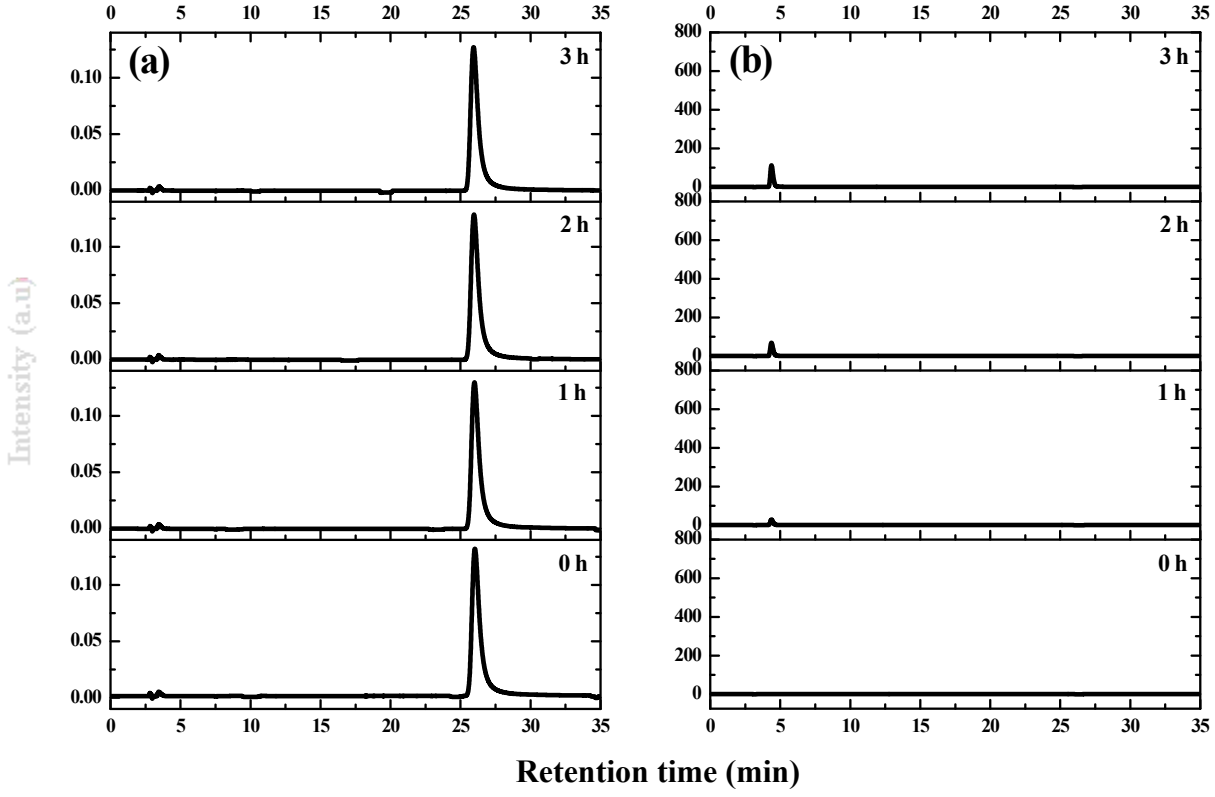


Fig. S7 High performance liquid chromatograms (HPLC) of (a) 4-NP and (b) 4-AP solutions after photocatalytic reduction reaction in the presence of Ga_2O_3 nanoparticles with different photo reaction times using UV and fluorescence detectors, respectively.

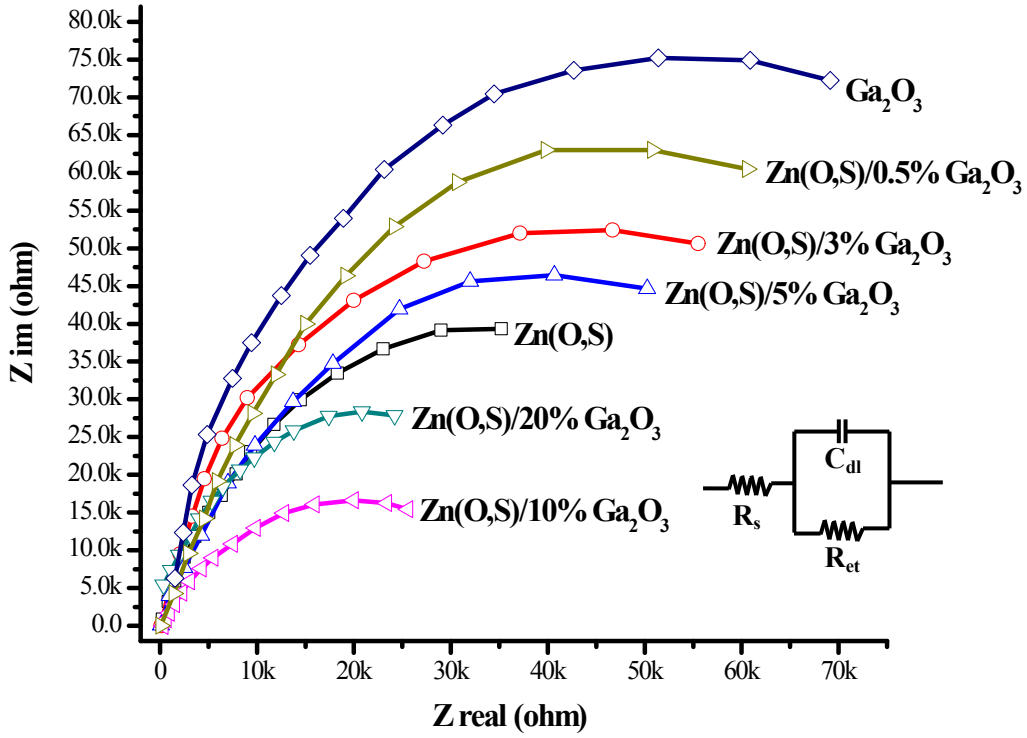


Fig. S8 Electrochemical impedance spectra (EIS) of Zn(O,S)/Ga_2O_3 nanocomposites with different contents of Ga_2O_3 and as-prepared Ga_2O_3 using glassy carbon electrode, platinum, and Ag/AgCl as working, counter, and reference electrodes, respectively in 0.1 M KCl as the electrolyte under the 352 nm UV lamp (24 W) illumination. The Randles equivalent circuit was used to fit the experimental data. The symbols of R_s, R_{et}, and C_{dl} were respectively related to the electrolyte resistance, electron transfer resistance, and double layer capacitance. Based on the Randles fitting, the calculated electron transfer resistance values of Zn(O,S), Zn(O,S)/0.5% Ga_2O_3, Zn(O,S)/3% Ga_2O_3, Zn(O,S)/5% Ga_2O_3, Zn(O,S)/10% Ga_2O_3, Zn(O,S)/20% Ga_2O_3, and Ga_2O_3 were 55.7 kΩ, 91.3 kΩ, 77.85 kΩ, 71.8 kΩ, 36.5 kΩ, 43.8 kΩ, and 98.0 kΩ, respectively. The lowest resistance indicated the most efficient electron transfer on the interfaces between

catalyst and electrolyte during the photocatalytic reaction for hydrogen production and 4-NP reduction.

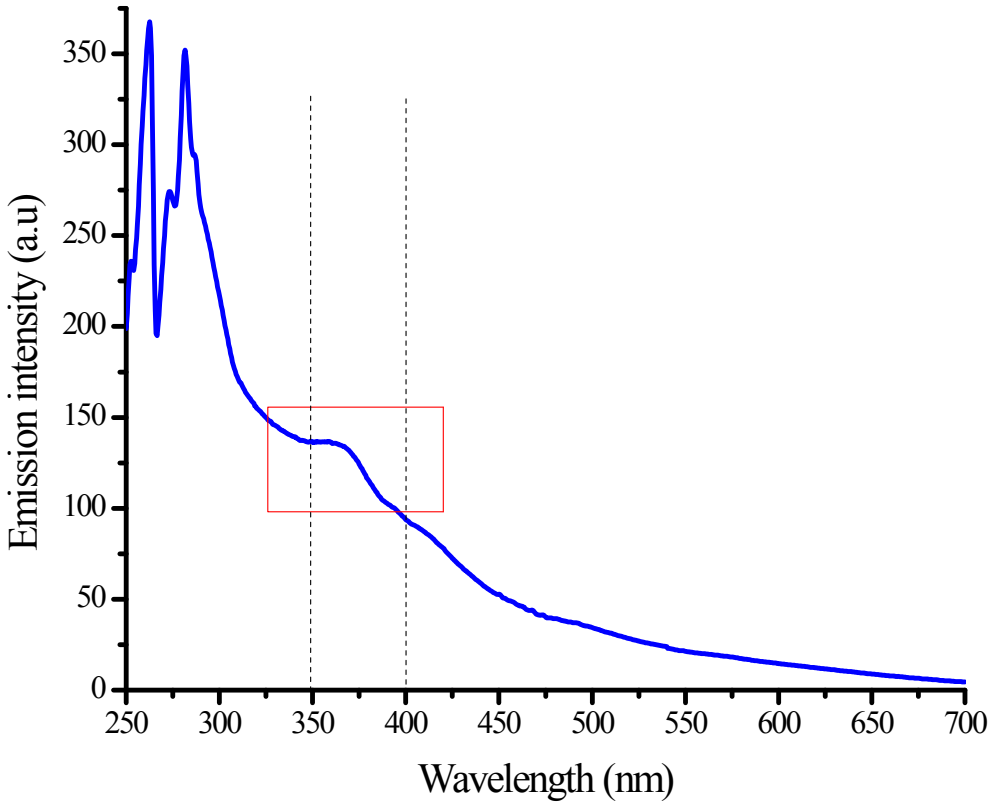


Fig. S9 Photoluminescence (PL) spectra of as-prepared Ga_2O_3 powder revealed a small broad emission peak indicated by a red depicted rectangle which was related to defect state occurred in the Ga_2O_3 to make it possible to be excited with 352 nm photon..

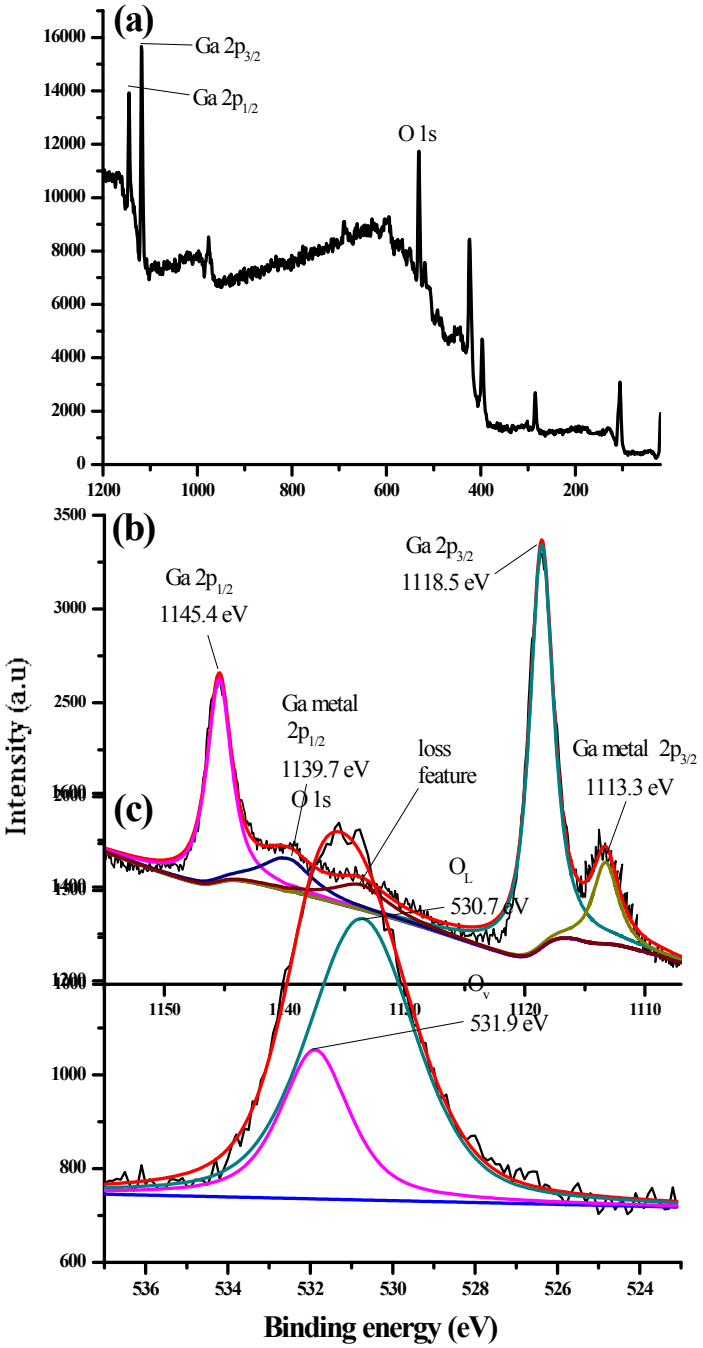


Fig. S10. (a) Full scan and high resolution XPS spectra of Ga 2p and O 1s peaks for as-prepared Ga_2O_3