

Supplementary material for:

Synergistic effect of Zinc Selenide - Reduced Graphene Oxide towards enhanced solar-light-responsive photo current generation and photocatalytic 4-Nitrophenol degradation

Koushik Chakraborty^a, Sankalpita Chakrabarty^a, Tanusri Pal^{b,*}, Surajit Ghosh^{a,*}

^aDepartment of Physics & Technophysics, Vidyasagar University, Midnapore 721102, WB, India

^bDepartment of Physics, Midnapore College, Midnapore 721101, WB, India

*Address corresponds to: surajit@mail.vidyasagar.ac.in (SG); tanusri.pal@gmail.com (TP)

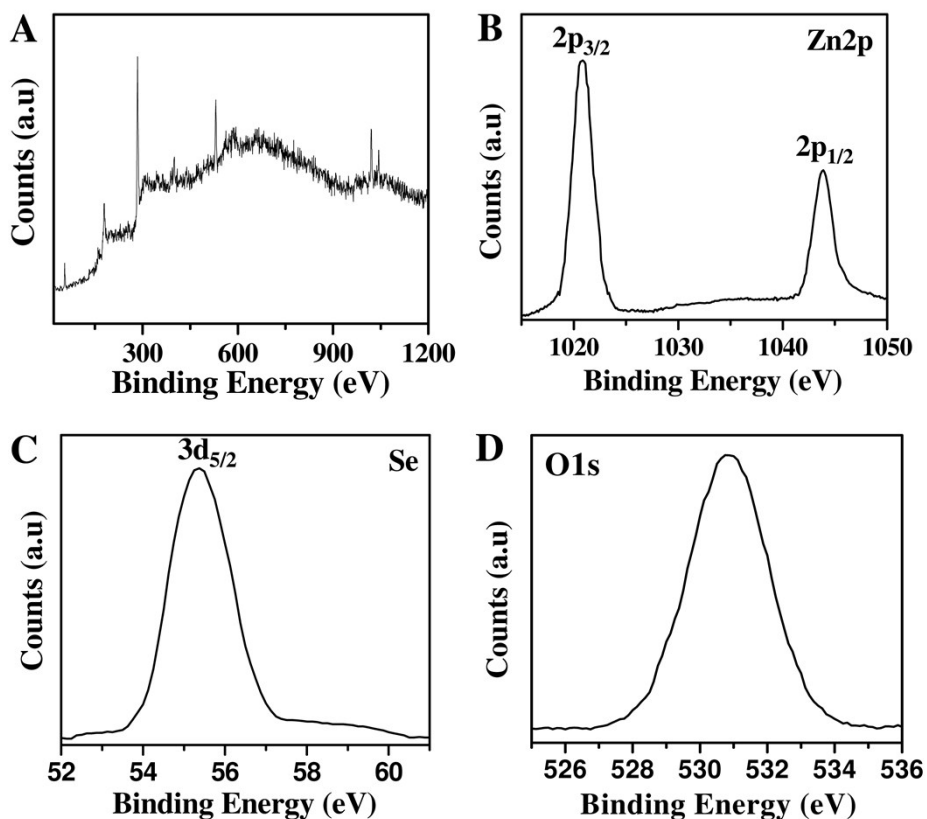


Figure S1 (A) XPS survey spectrum of RGO-ZnSe composite. High resolution XPS spectra of (B) Zn2p (C) Se3d and (D) O1s.

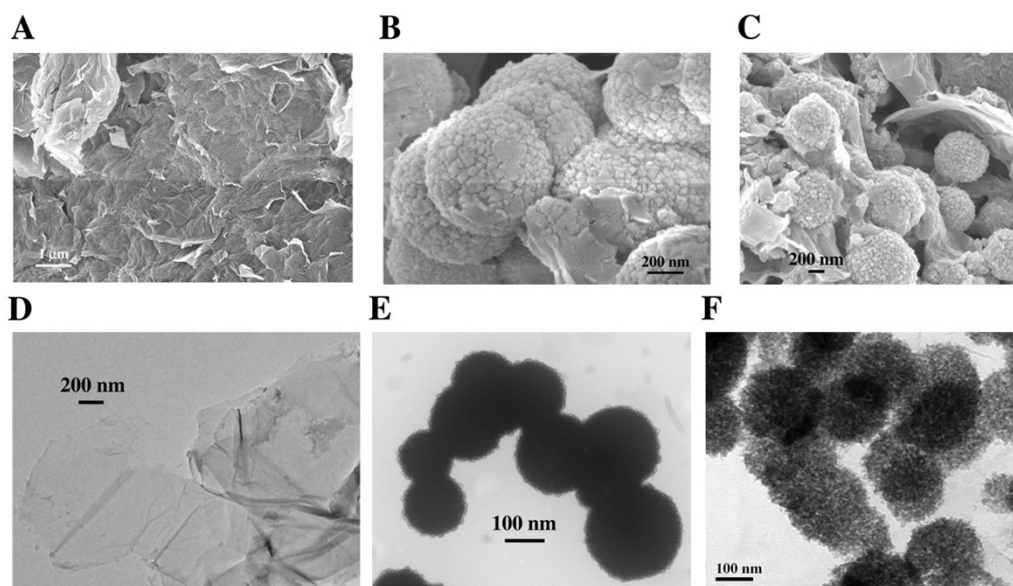


Figure S2 SEM images of (A) RGO (B) controlled-ZnSe (C) RGO-ZnSe composite. TEM images of (D) RGO (E) controlled-ZnSe and (F) RGO-ZnSe composite.

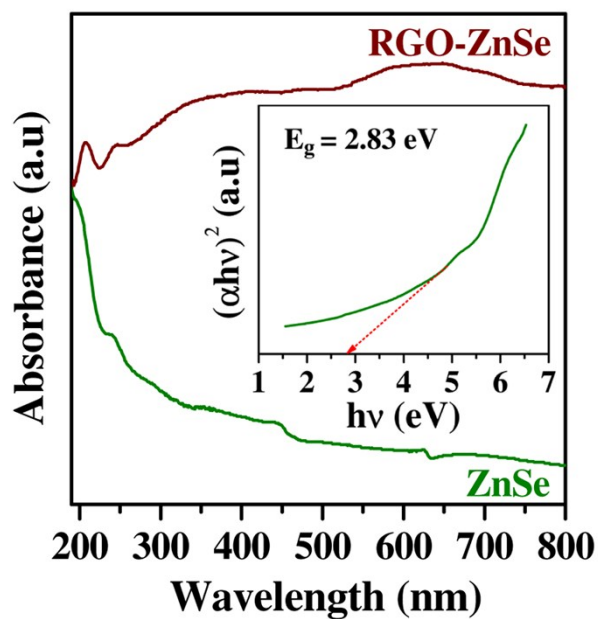


Figure S3 Optical absorption spectra of controlled-ZnSe and RGO-ZnSe composite thin film on quartz substrate. Plot of $(\alpha h\nu)^2$ vs photon energy for controlled-ZnSe is shown in the inset.

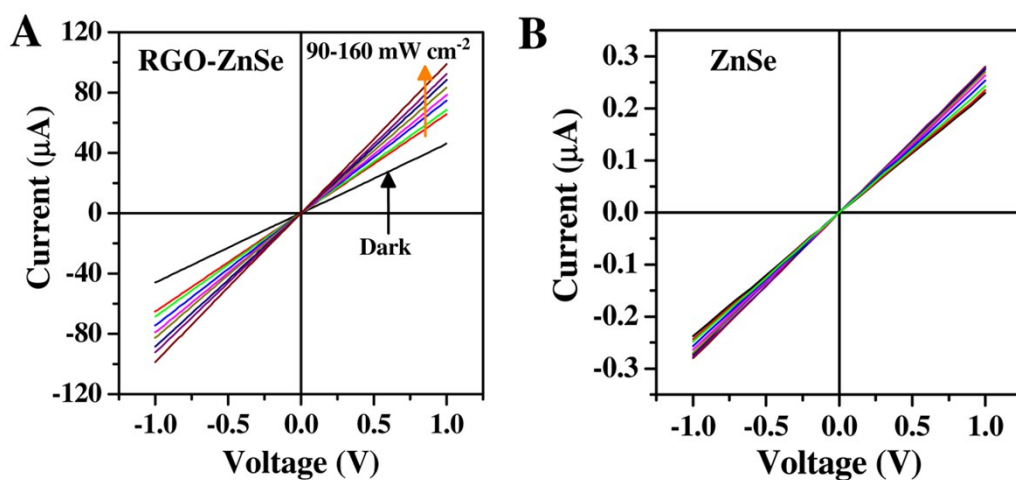


Figure S4 Current – Voltage (I–V) characteristics for RGO–ZnSe composite and controlled –ZnSe thin film photodetector under dark condition and under different illumination intensity at room temperature.

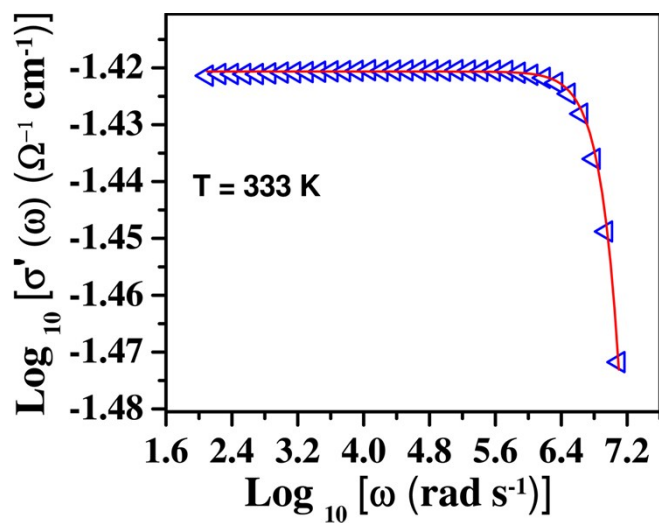


Figure S5 Frequency dependence of electrical conductivity for temperatures 333K (full scale spectra) with the fittings of Equation (8).

The real (ϵ') and imaginary (ϵ'') parts of the complex dielectric constant (ϵ^*) can be calculated from the equations

$$\epsilon' = \frac{(C - C_0)d}{\epsilon_0 A} \quad \text{and} \quad \epsilon'' = \frac{\sigma}{\omega \epsilon_0}$$

Where, d is the thickness, A is the cross-sectional area and C is the capacitance of the RGO-ZnSe palate, C_0 is the null capacitance, σ is the conductivity, ϵ_0 is the permittivity of free space.

The real (M') and imaginary (M'') parts of the complex electrical modulus ($M^* = 1/\epsilon^*$) was calculated from the equations

$$M' = \frac{\epsilon'}{\epsilon'^2 + \epsilon''^2} \quad \text{and} \quad M'' = \frac{\epsilon''}{\epsilon'^2 + \epsilon''^2}$$

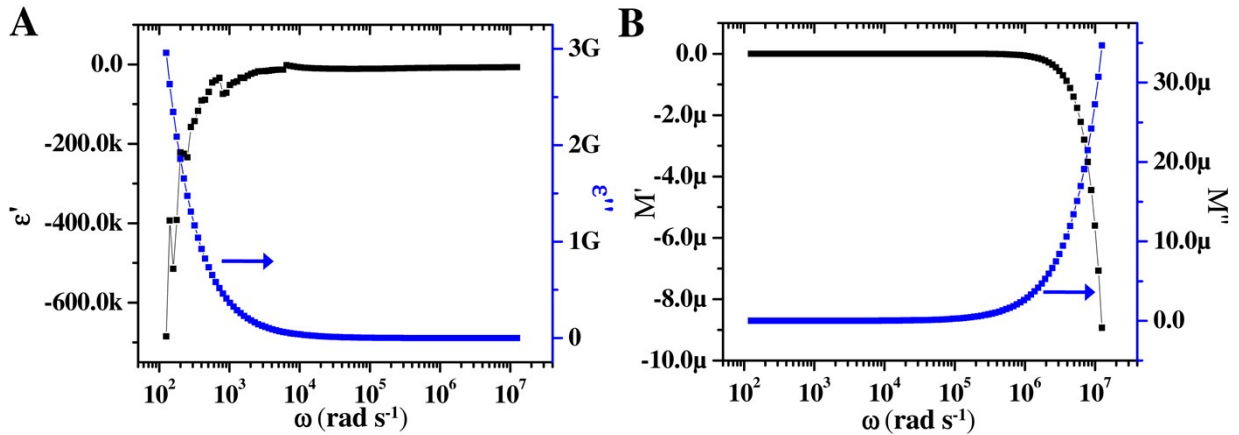


Figure S6 Variation of (A) ϵ' and ϵ'' with frequency and (B) M' and M'' with frequency of the RGO-ZnSe composite at a temperature 323 K.

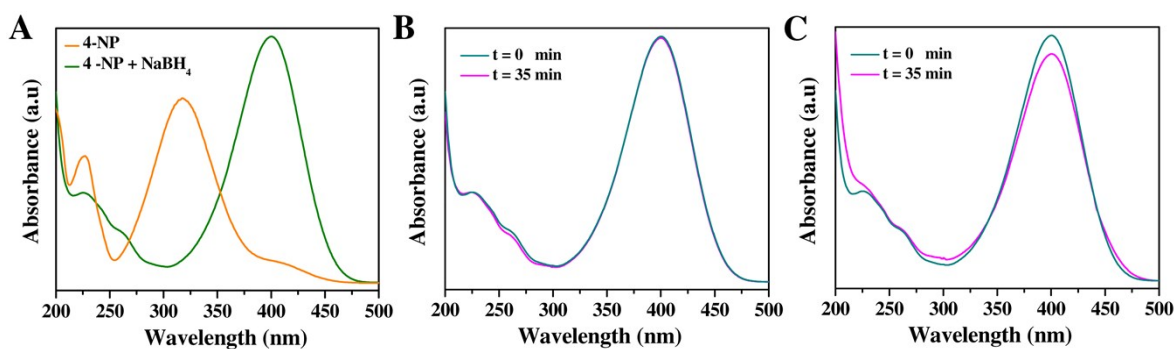


Figure S7 UV-vis absorption spectrum of aqueous solution of (A) 4-NP and 4-NP with NaBH₄. (B) 4-NP with NaBH₄ without catalyst under light. (C) 4-NP and NaBH₄ with RGO-ZnSe catalyst under dark.

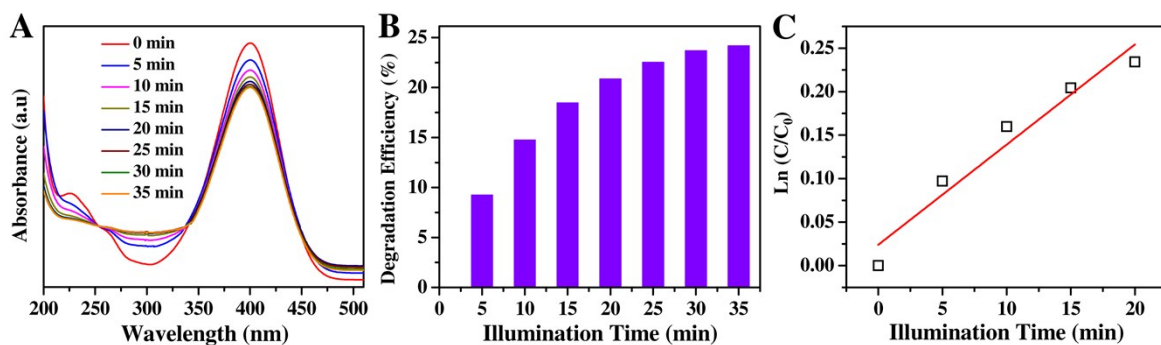


Figure S8 (A) UV-vis absorption spectra of 4-nitrophenol ion in presence of controlled-RGO. (B) The variation of the photo degradation efficiency of controlled RGO as a function of illumination time. (C) Plot of $\ln(C_0/C)$ as a function of illumination time for the photocatalysis of 4-NP aqueous solution in presence of RGO.

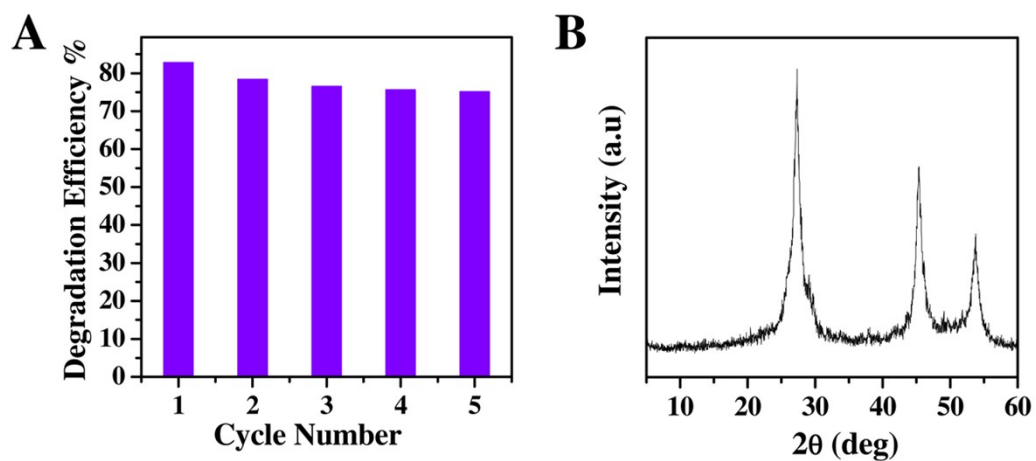


Figure S9 (A) Photodegradation efficiency of RGO-ZnSe composite for different degradation cycle (B) XRD pattern of the RGO-ZnSe composite after five cycles of degradation of 4-NP