

Molecular Energy Transfer: Utilizing Biogenically-Synthesized ZnMn_2O_4 Nanoparticles in *Arachis hypogaea* Seeds for Photoluminescence, Adsorption, and Photocatalytic Applications

*Aakash Venkatesan*¹, *Aatika Nizam*^{1*}, *Anila Rose Cherian*¹, *Rupali Nainesh Patel*², *Jobi Xavier*³, *Pooja K R*⁴, *Harini R*⁵, *Nagaraju G*^{6*}

¹ Department of Chemistry, Christ University, Bangalore-560029, India

² Department of Physics, Christ University, Bangalore-560029, India

³ Department of Life Sciences, Christ University, Bangalore-560029, India

⁴ Department of Chemistry, Rani Channamma University, Belagavi 591156, India.

⁵ Department of Electronics and Communication Engineering, Govt. Polytechnic, Hiriyyuru – 577599, India

⁶ Energy Materials Research Laboratory, Department of Chemistry, Siddaganga Institute of Technology, Tumakuru 572103, India

Corresponding author email id: nagarajugn@gmail.com, aatika.nizam@christuniversity.in

3. Results and Discussions

3.2. Fourier Transform Infrared Spectroscopy (FTIR) analysis

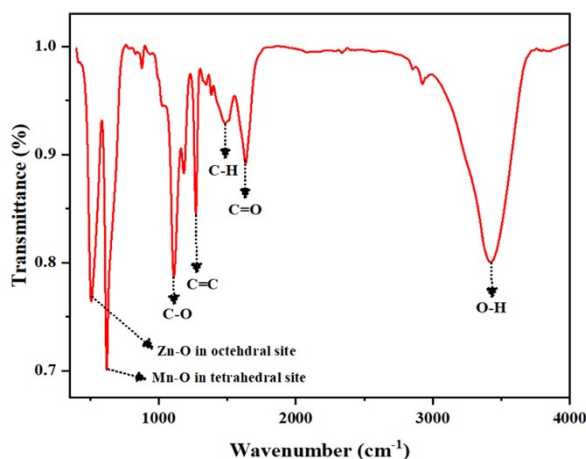


Figure S1: FTIR spectrum of ZnMn_2O_4 NPs

Table S1: The FTIR absorption band values of ZnMn_2O_4 NPs.

Type of Nanoparticle	Absorption band	
	Zn-O band (cm^{-1})	Mn-O band (cm^{-1})

ZnMn ₂ O ₄ (1:0.5)	521	621
ZnMn ₂ O ₄ (1:1)	510	619
ZnMn ₂ O ₄ (1:1.5)	511	619

3.3. UV-Visible Spectroscopy Studies

Table S2: Optical bandgap, valence band, and conduction band energies with-respective to NPs

<i>Type of Nanoparticle</i>	<i>Optical band gap energy (eV)</i>	<i>Valence band energy (eV)</i>	<i>Conduction band energy (eV) (b)</i>
ZnMn ₂ O ₄ (1:0.5)	5.05 eV	3.605 eV	-1.445 eV
ZnMn ₂ O ₄ (1:1)	4.10 eV	3.130 eV	-0.970 eV
ZnMn ₂ O ₄ (1:1.5)	5.31 eV	3.735 eV	-1.575 eV

3.4. Photoluminescence (PL) analysis

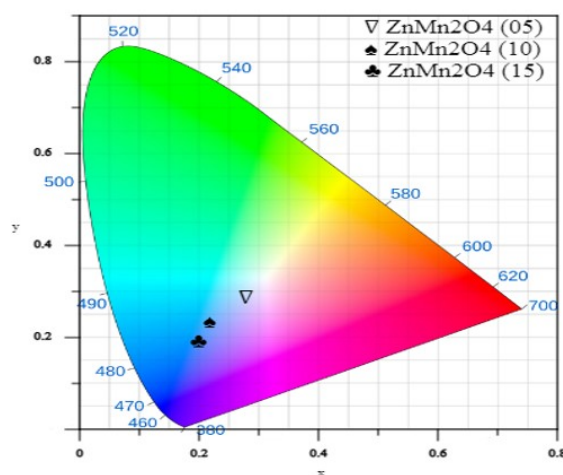


Figure S2: CIE diagram of ZnMn₂O₄ NPs (1:0.5, 1:1, 1:1.5)

3.8. Adsorption property

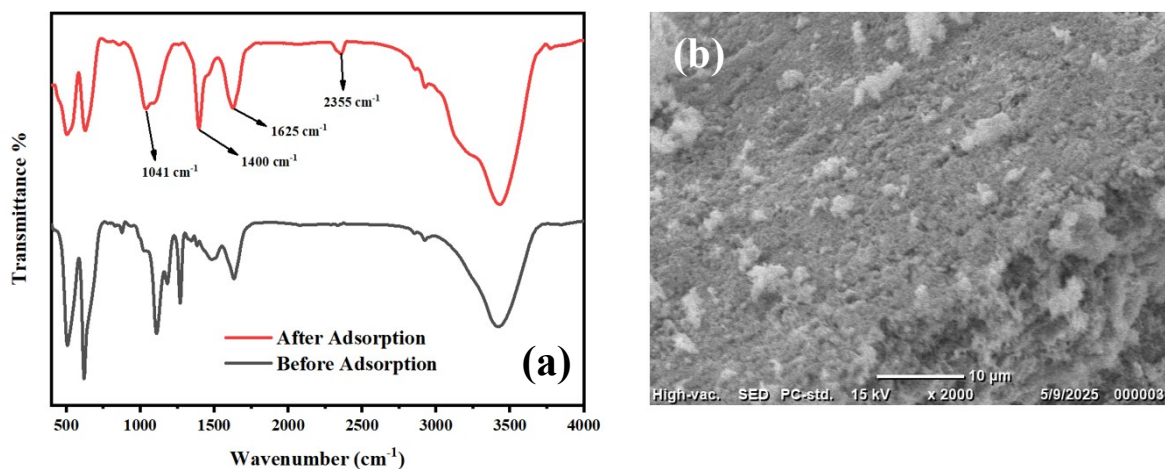


Figure S3: (a) FTIR after and before adsorption (b) SEM image of ZnMn₂O₄ after adsorption

3.9.3. Degradation Kinetics

Table S3: Rate constant values (k) for varying Catalytic dosage

Catalytic dosage (mg)	5	10	15	20
k value (min ⁻¹)	7.98 x 10 ⁻³ ± 0.0001	5.56 x 10 ⁻³ ± 0.00015	4.10 x 10 ⁻³ ± 0.00013	3.57 x 10 ⁻³ ± 0.0002

Table S4: Rate constant values (k) for varying Dye concentration

Dye Concentration (mg)	5	10	15	20
k value (min ⁻¹)	7.98 x 10 ⁻³ ± 0.0001	5.89 x 10 ⁻³ ± 0.00017	5.33 x 10 ⁻³ ± 0.0003	3.22 x 10 ⁻³ ± 0.00025

Table S5: Rate constant values (k) for varying pH Value

pH Value	Basic	Neutral	Acidic
k value (min^{-1})	$8.27 \times 10^{-3} \pm 0.00005$	$7.14 \times 10^{-3} \pm 0.0001$	$2.16 \times 10^{-3} \pm 0.00023$

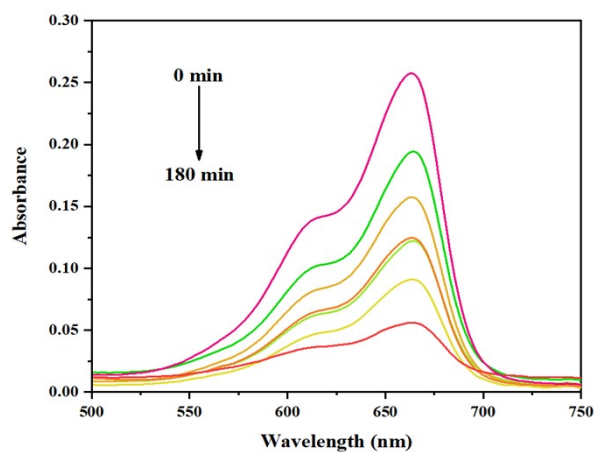


Figure S4: Absorption spectra of optimized photocatalytic degradation of MB dye by ZnMn_2O_4 NPs

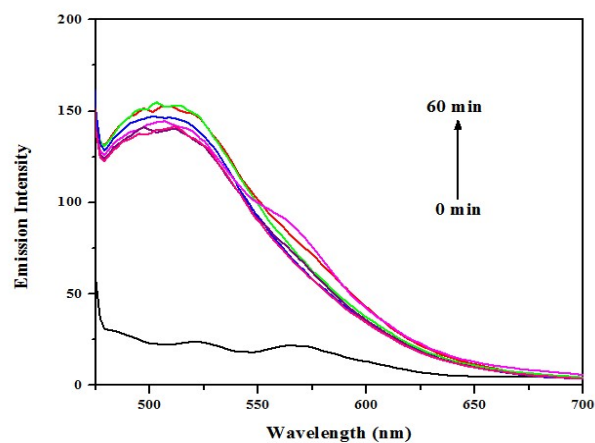
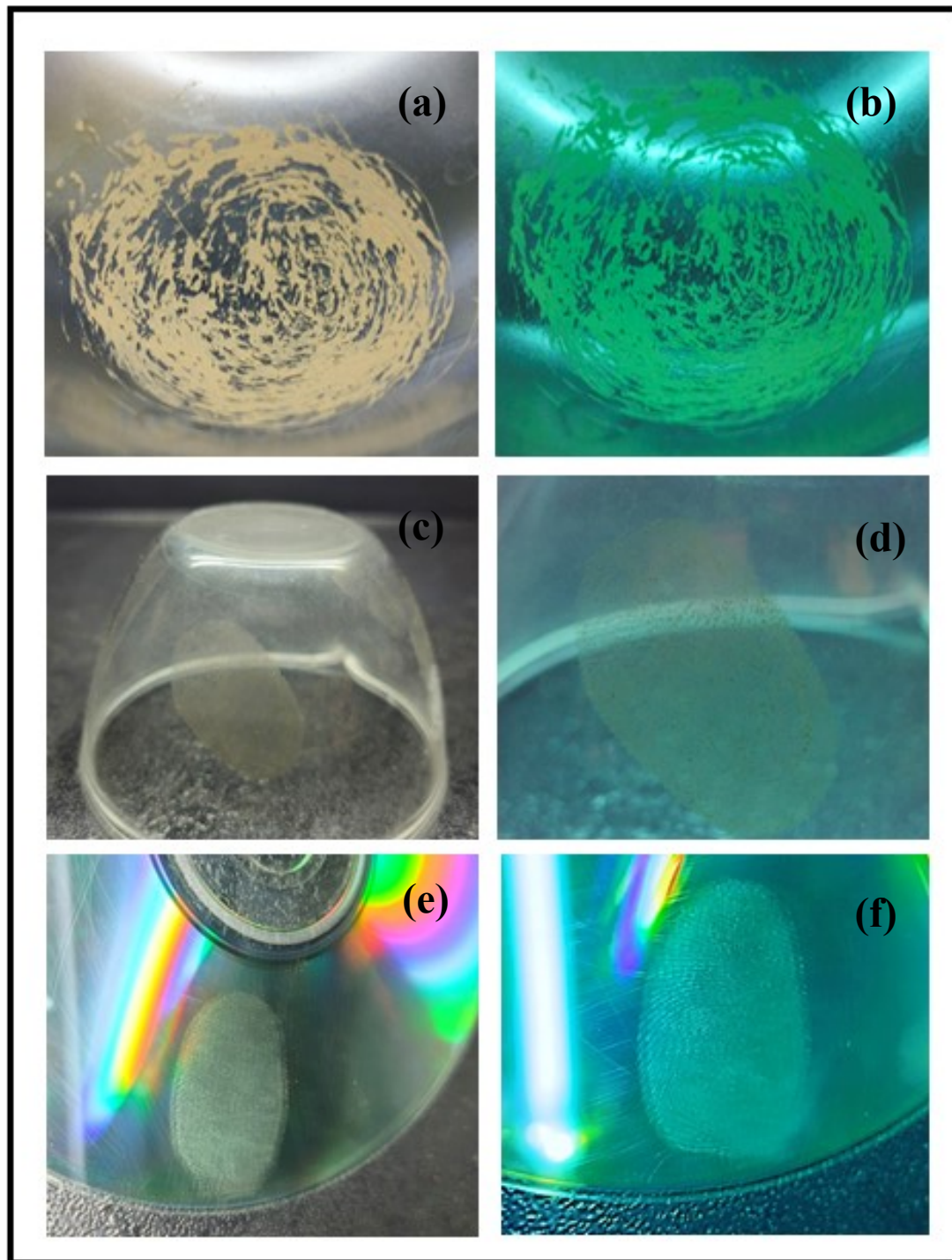


Figure S5: Detection of $\dot{\text{O}}\text{H}$ radicals under UV light radiation

3.11. Latent Fingerprinting (LFPs) analysis



Figur

e S6: LFPs image captured on different material surfaces (a) Mortar (Visible light) (b) Mortar (UV light 254 nm) (c) Glass cup (Visible light) (d) Glass cup (UV light 254 nm) (e) CD drive (Visible light) (f) CD drive (UV light 254 nm).