

Reassessing the Role of Carbon Shells in Magnetite Nanoparticles: A Comparative Adsorption Study of Ionic Dyes

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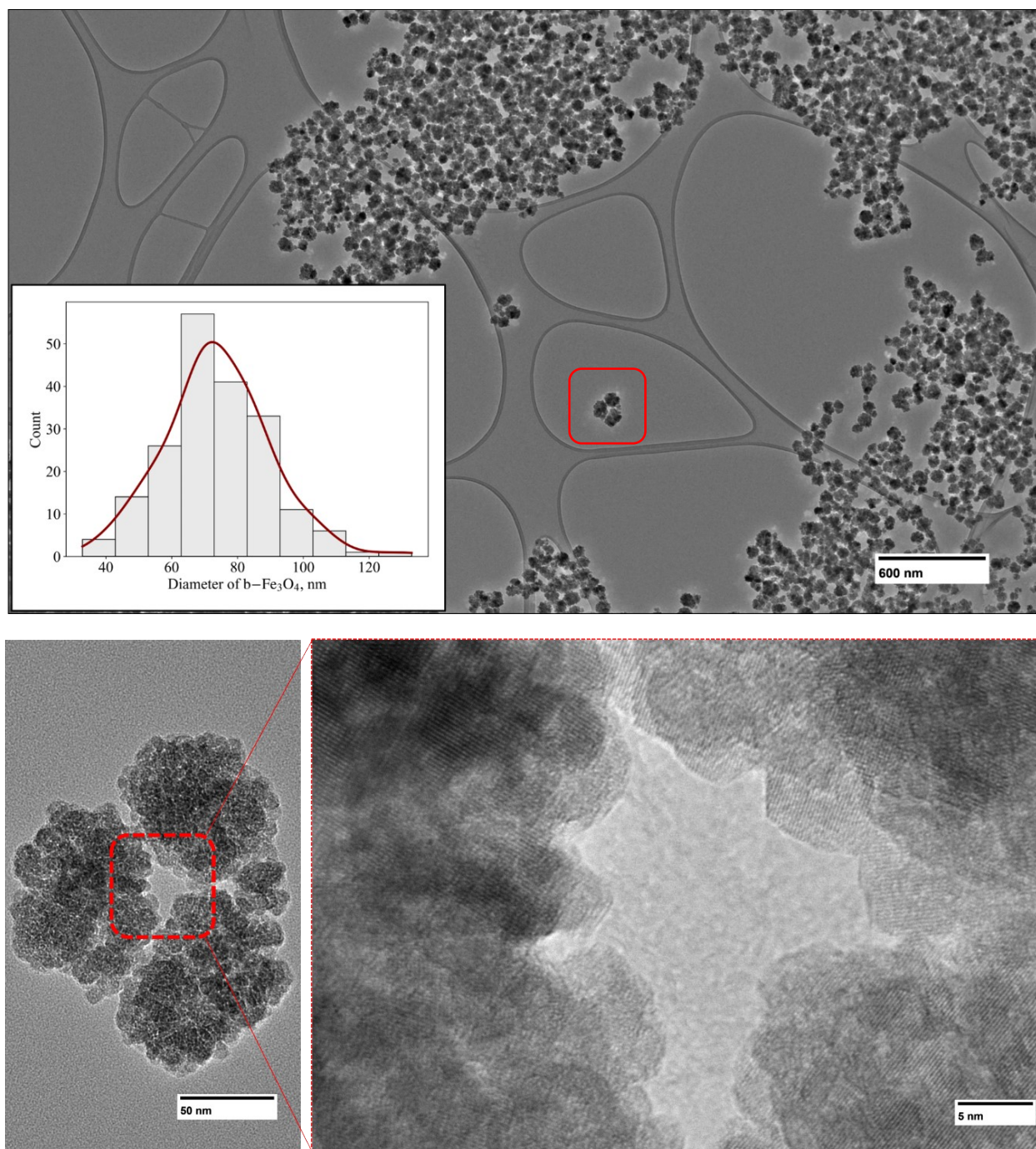


Figure S1. TEM images of b-Fe₃O₄ NPs demonstrating size distribution (top panel) along with close up images of individual NPs demonstrating crystalline structure extending all the way to the edges (bottom panel)

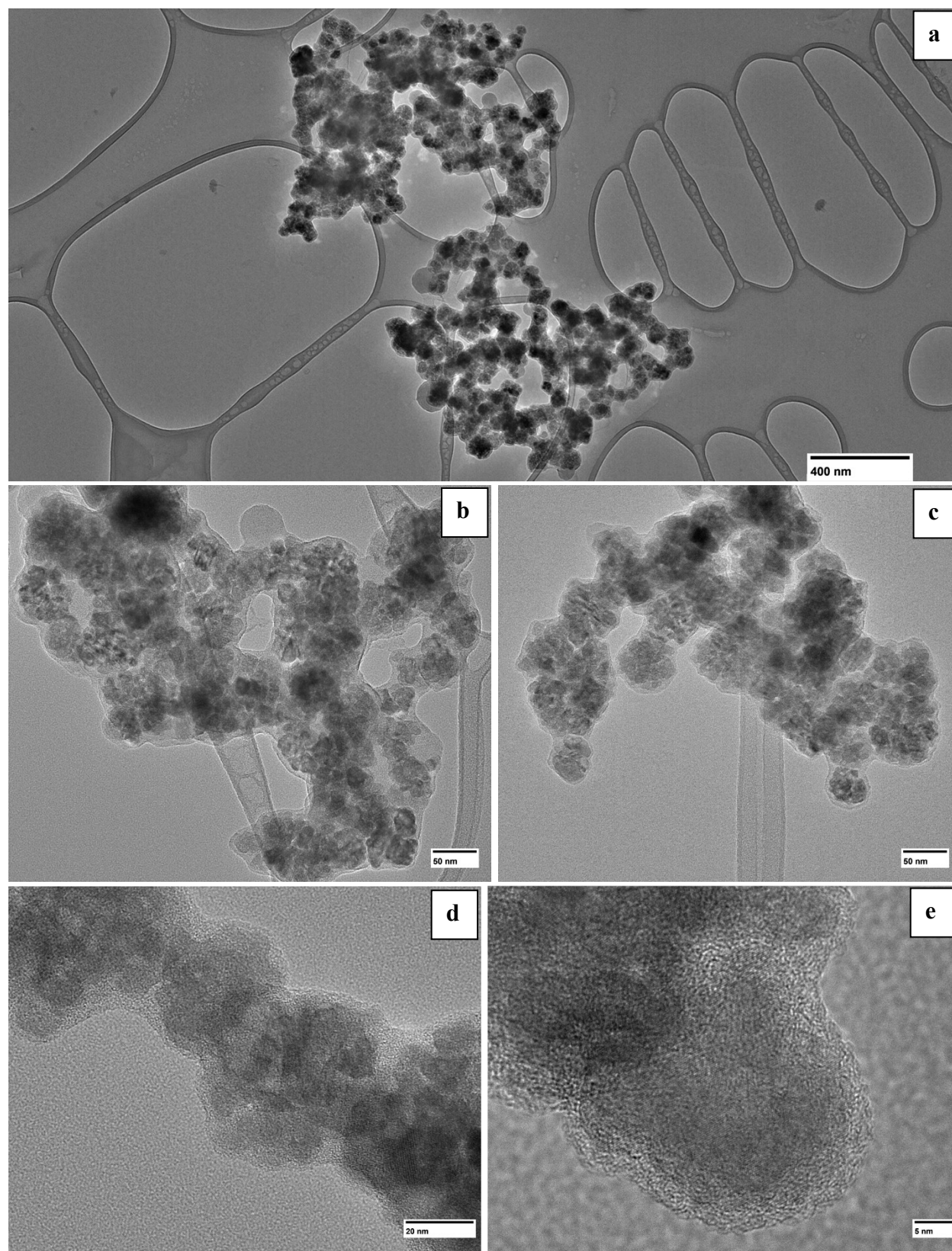


Figure S2. TEM images of $c\text{-Fe}_3\text{O}_4$ NPs demonstrating encapsulation of magnetite NPs with carbon shell (a-c); close up images of edges depicting coverage of crystalline structure with amorphous carbon layer (d-e)

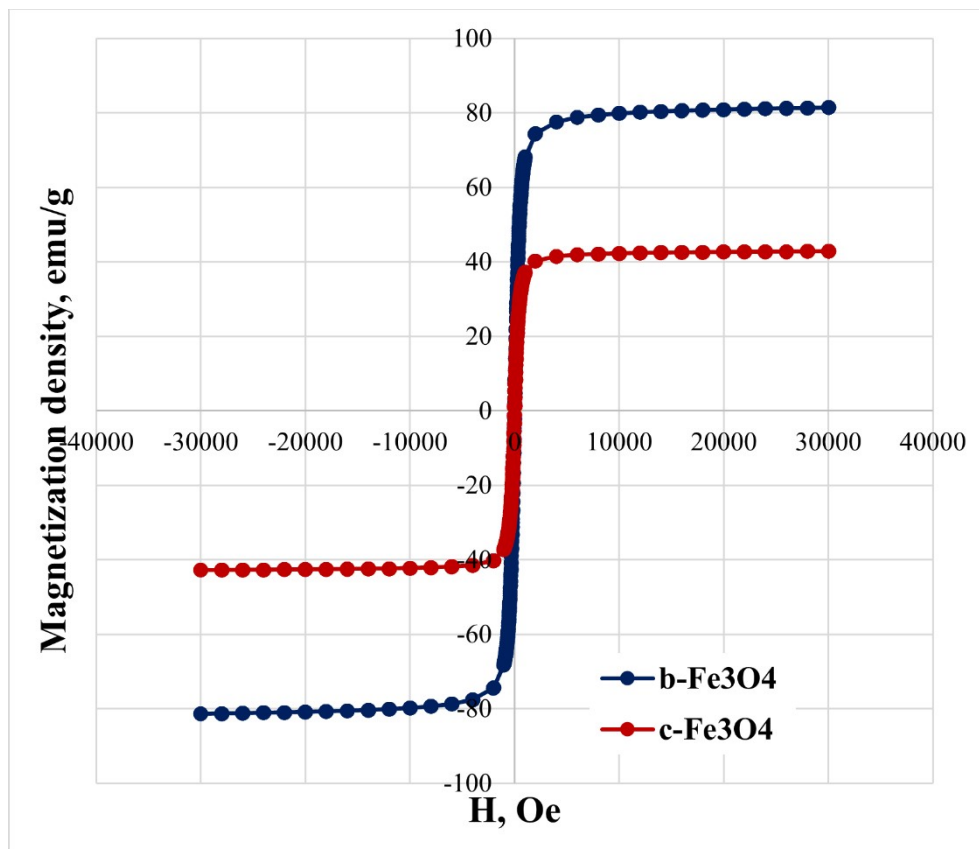


Figure S3. Room-temperature magnetization curves for *b*-Fe₃O₄ and *c*-Fe₃O₄ NPs.

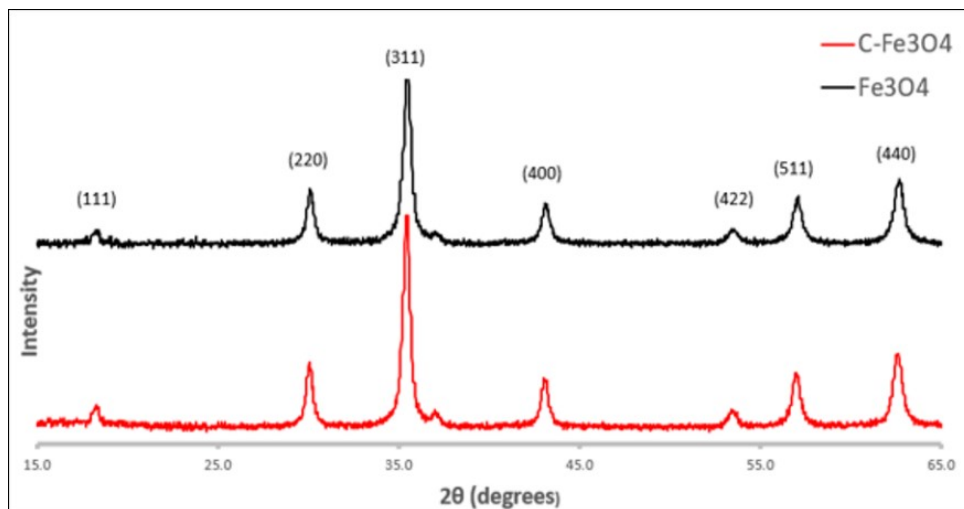


Figure S4. XRD spectra for b- Fe_3O_4 and c- Fe_3O_4 NPs.

Congo Red Degradation Test (pH 2-10)

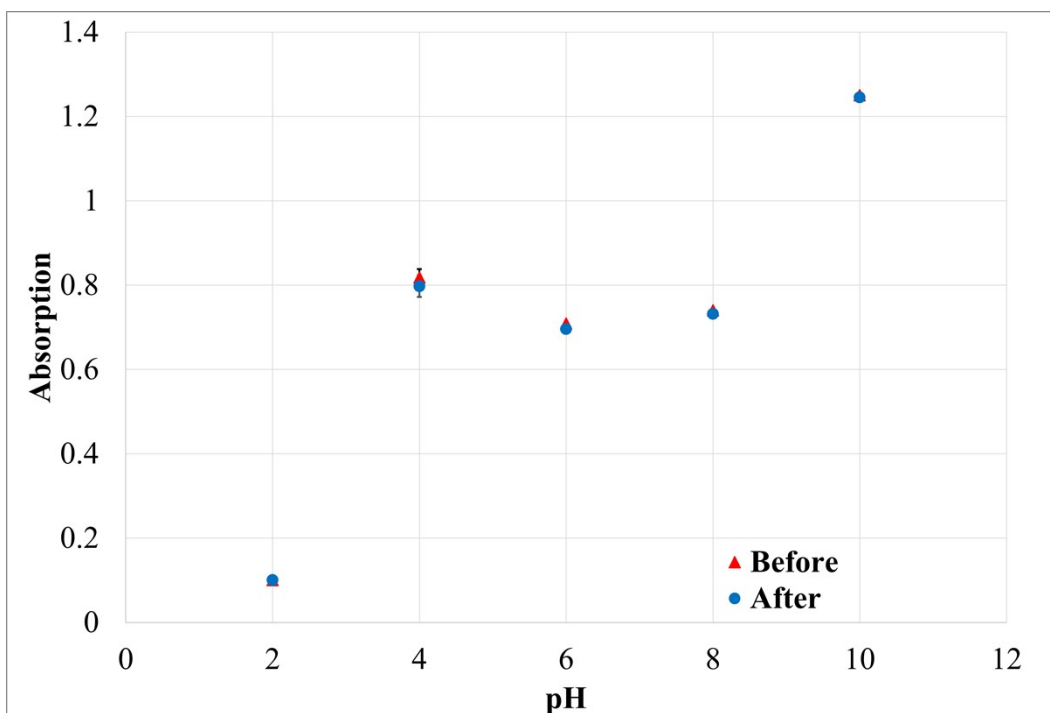


Figure S5. Degradation study of Congo red at pH 2-10 (no nanoparticles present)

To rule out plausible natural degradation or precipitation of dye, 20 ml solutions of CRed (20mg/L) were prepared across a pH range of 2-10 and placed on the orbital shaker for 24 hours. No nanoparticles were added to the solutions. Absorbance at 339 nm was measured for all samples before and after shaking. All experiments were performed in triplicate. As shown in Figure S5, no measurable degradation of the dye was observed across the tested pH range. The authors note that CRed gradually changes color at pH 4 from purple to red. As such, degradation test at pH 4 was performed after the color of the dye fully transitioned to red.

Methylene Blue Degradation Test (pH 2)

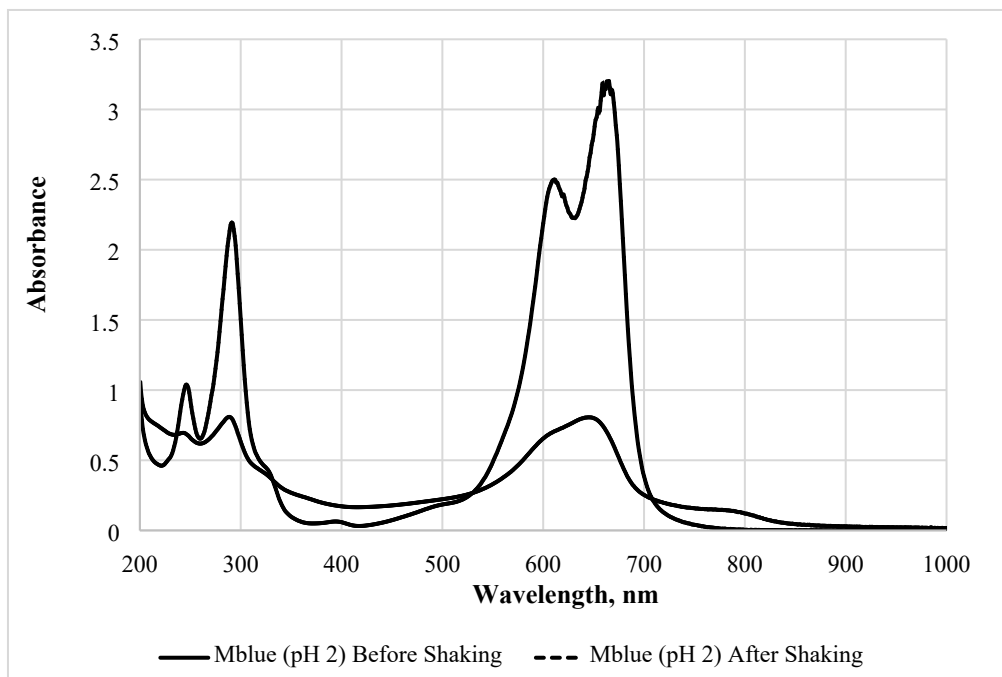


Figure S6. UV-vis spectra of MBlue at pH 2 before and after shaking.

The purpose of this experiment was to verify whether MBlue undergoes natural degradation at pH 2 in the absence of nanoparticles and to distinguish degradation effects from the adsorption effects. The MBlue solution was prepared at a concentration of 20 mg/L and adjusted to pH 2, then placed on an orbital shaker at 150 rpm for 24 hours. The UV-vis absorption spectra were collected before and after shaking process. No nanoparticles were added in this experiment. It was determined that the absorbance dropped by 71.75% due to natural degradation alone. This value was then factored in for all experiments with MBlue at pH 2.

NPs	pH	Langmuir					Freundlich				
		q_{\max}	K_L	R^2	AIC	BIC	K_F	$1/n$	R^2	AIC	BIC
b-Fe₃O₄	CRed (4)	31.31	0.1627	0.936	33.71	24.84	8.67	0.253	0.754	51.15	52.28
	CRed (10)	(-)*	(-)*	0.974	36.46	37.26	0.09	1.152	0.980	33.68	34.48
c-Fe₃O	CRed (2)	(-)*	(-)*	0.616	48.26	47.85	4.71	1.163	48.26	47.85	52.28
	MBlue (10)	103.21	0.0064	0.927	26.05	25.94	3.10	0.554	0.972	19.26	19.15

Table S1. Langmuir and Freundlich adsorption isotherm parameters

*Despite high R^2 values, the Langmuir parameters obtained for CRed adsorption were not physically meaningful, indicating that the model assumptions were not satisfied.

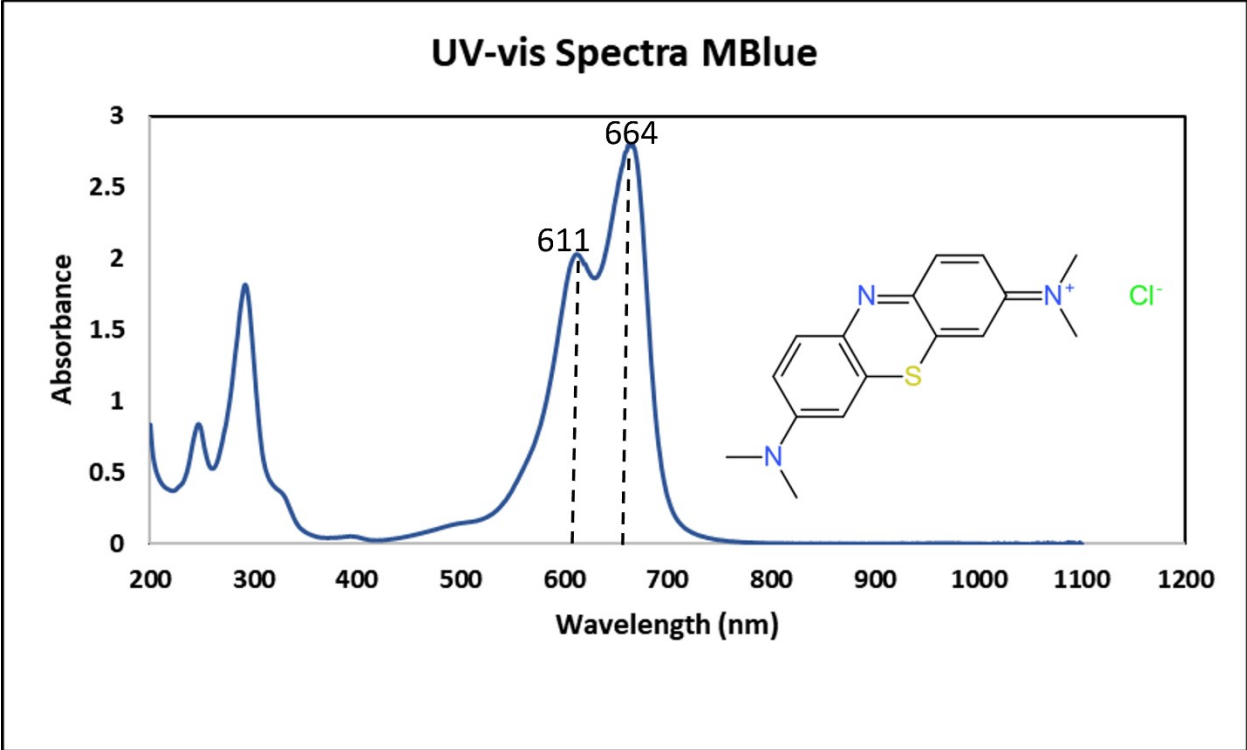


Figure S7. UV-vis spectra for methylene blue

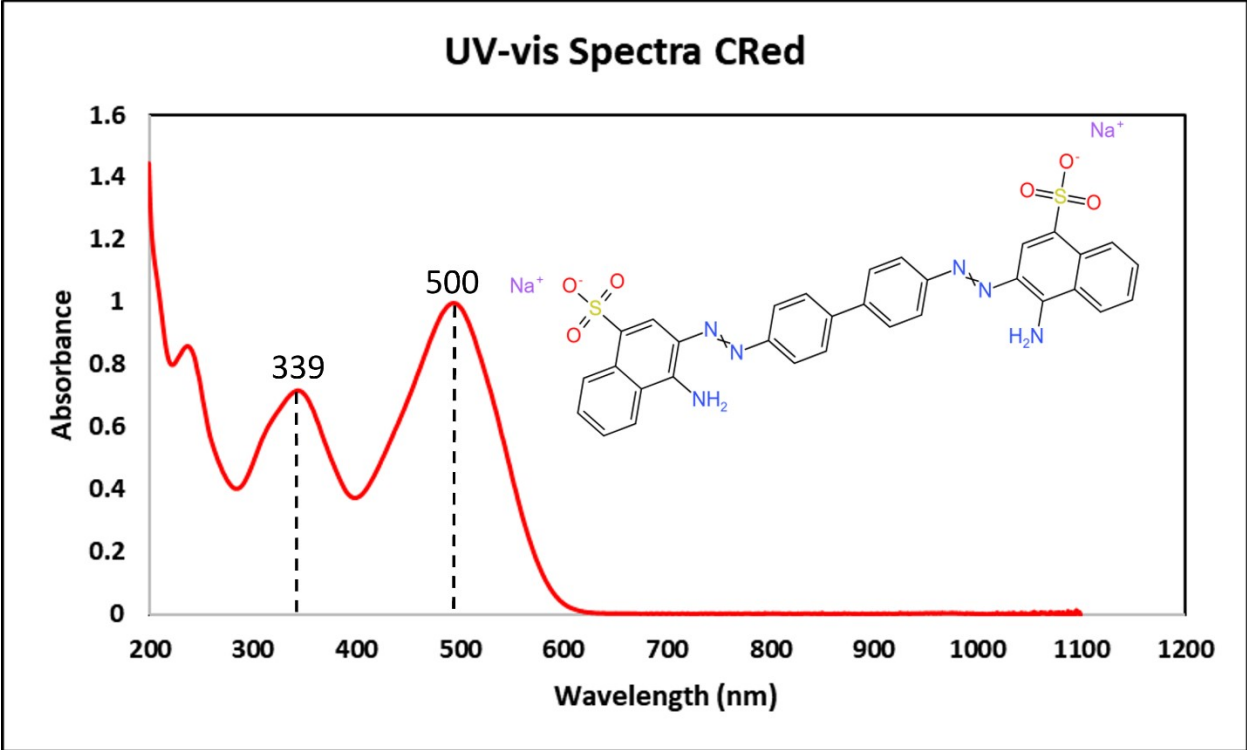


Figure S8. UV-vis spectra for Congo red