Supplementary Information (SI) for Environmental Science: Nano.

Supporting information

for

Facile Room-Temperature One-Pot Synthesis of Gold Nanoparticle-Embedded Hydrogel for Recyclable Dye Degradation and Antimicrobial Applications

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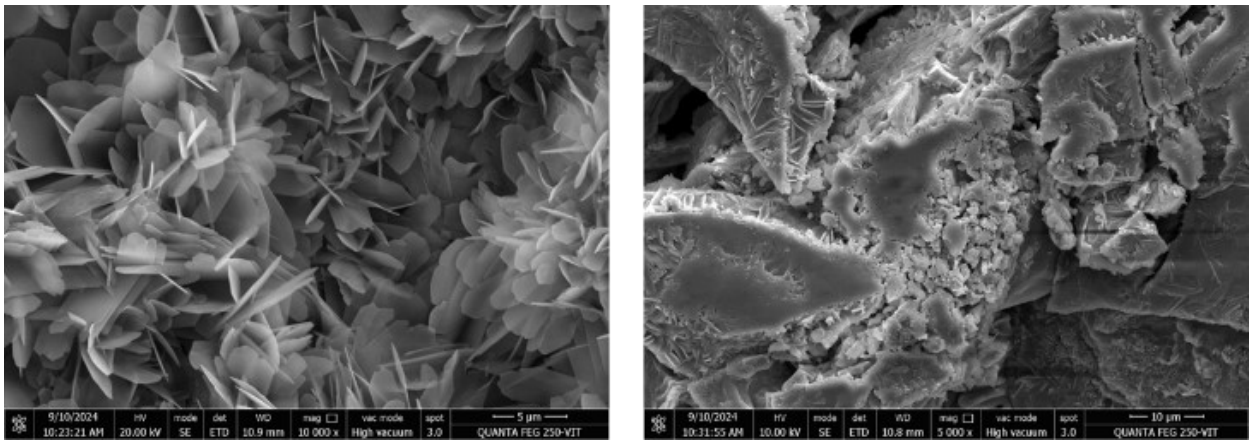

Figure S1: FESEM images of Alg-CA.

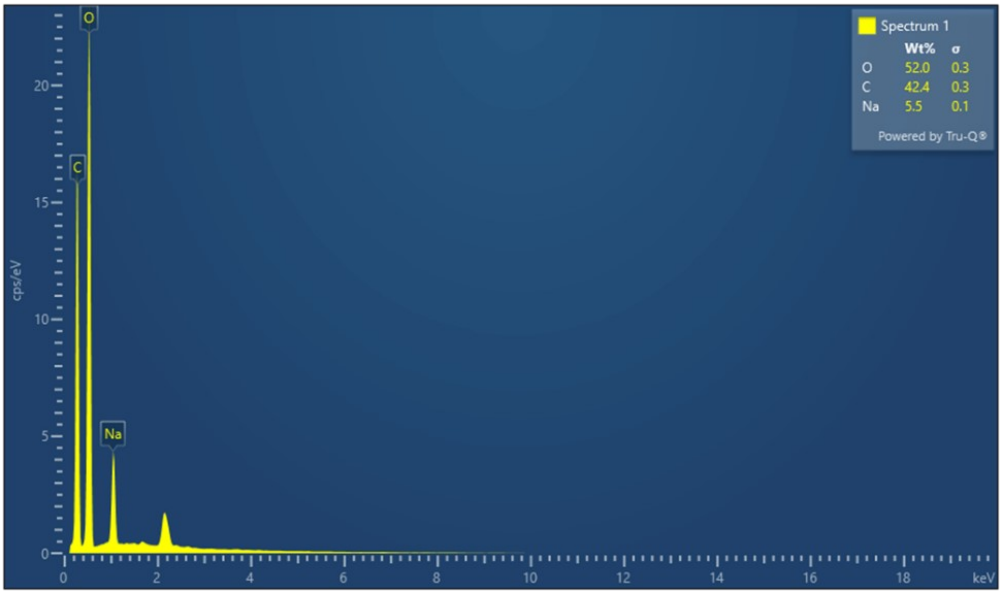

Figure S2: Energy dispersive X-ray spectrometry (EDX) spectrum for Alg-CA.

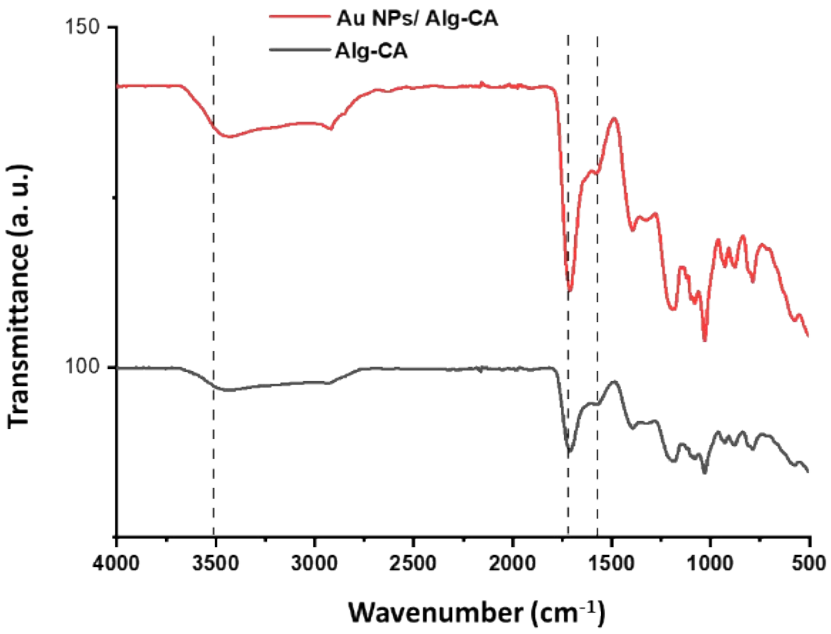

Figure S3: Comparative FTIR analysis of Au NPs/Alg-CA (red line) and Alg-CA (black line).

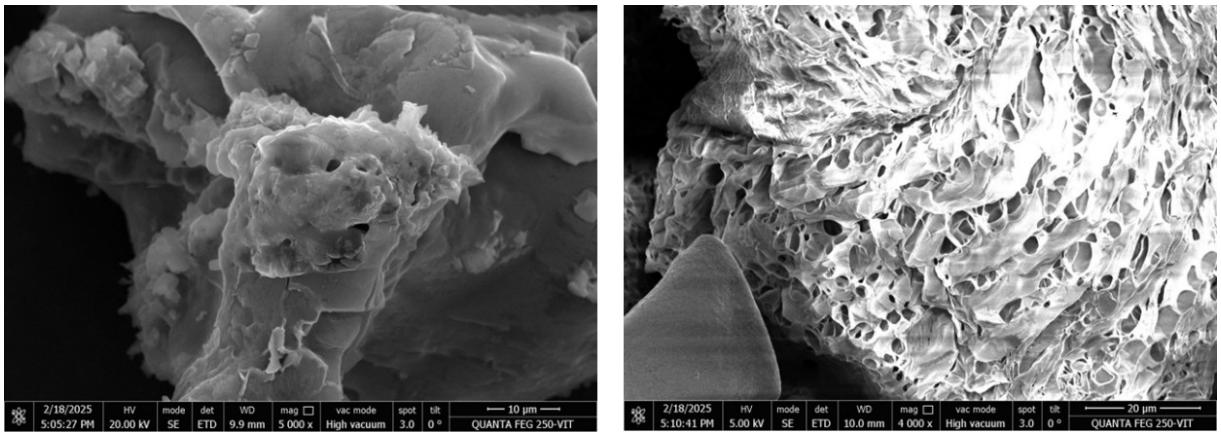

Figure S4: FESEM images of Au NPs/Alg-CA.

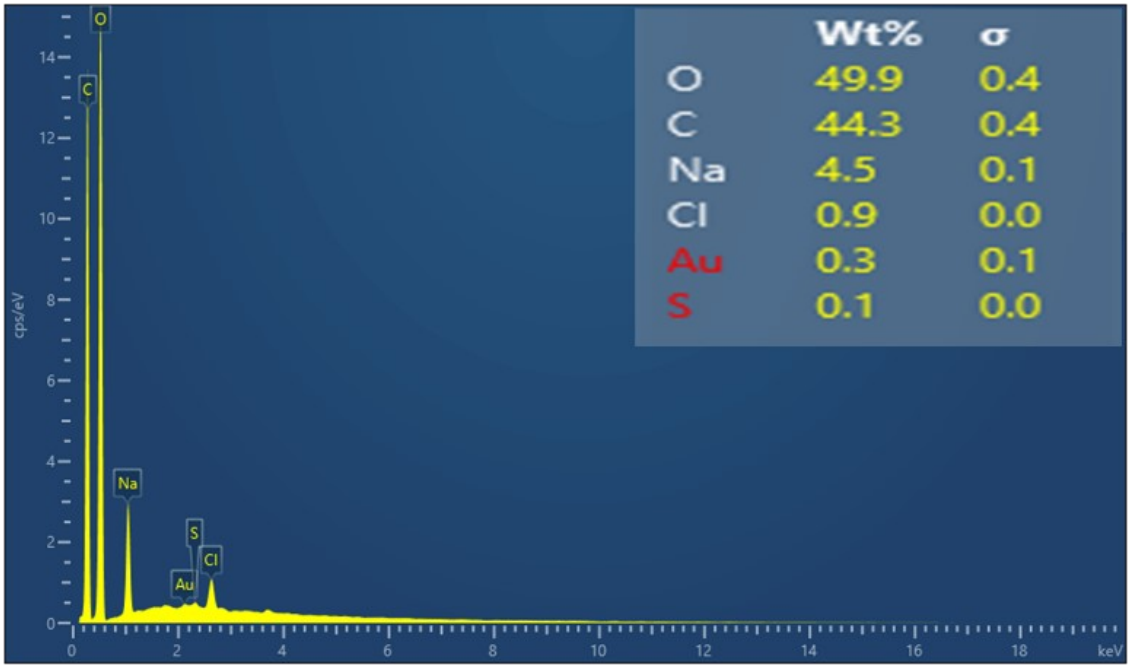

Figure S5: EDX spectrum of Au NPs/Alg-CA.

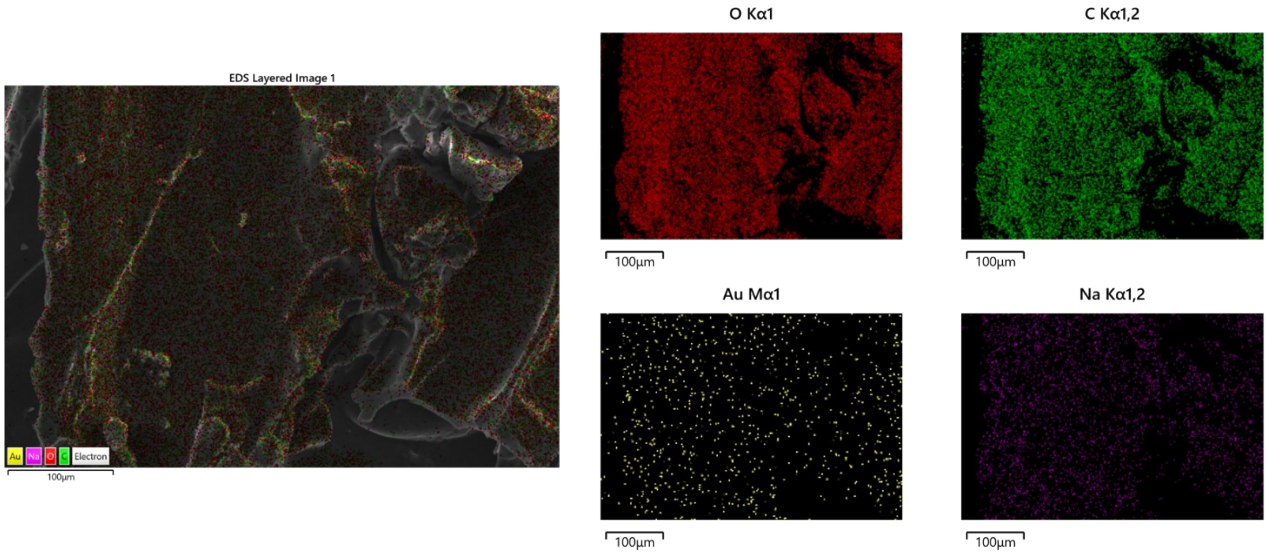

Figure S6: Energy dispersive X-ray spectrometry (EDX Mapping) spectrum for Au NPs/Alg-CA

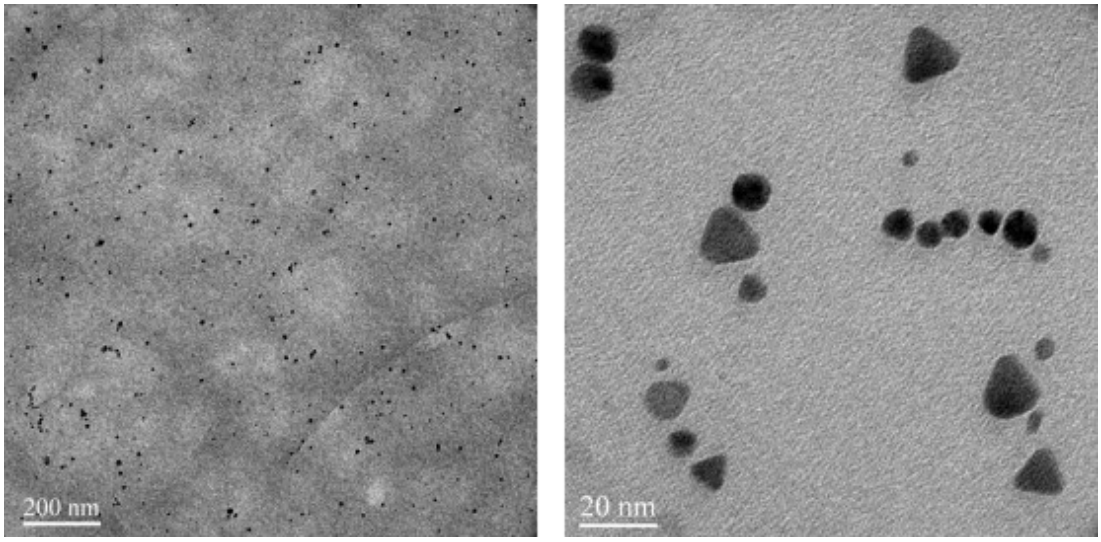

Figure S7: TEM images of Au NPs/Alg-CA (with 0.5 x 10^{-3} M $HAuCl_4$).

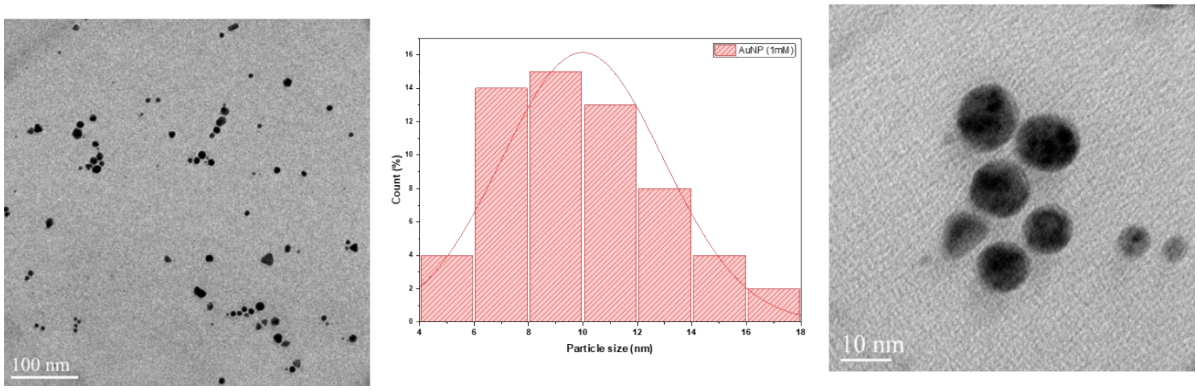

Figure S8: TEM images of Au NPs/Alg-CA (with 1.0 x 10^{-3} M $HAuCl_4$), and size distribution histogram with Gaussian fitting.

Dye Degradation

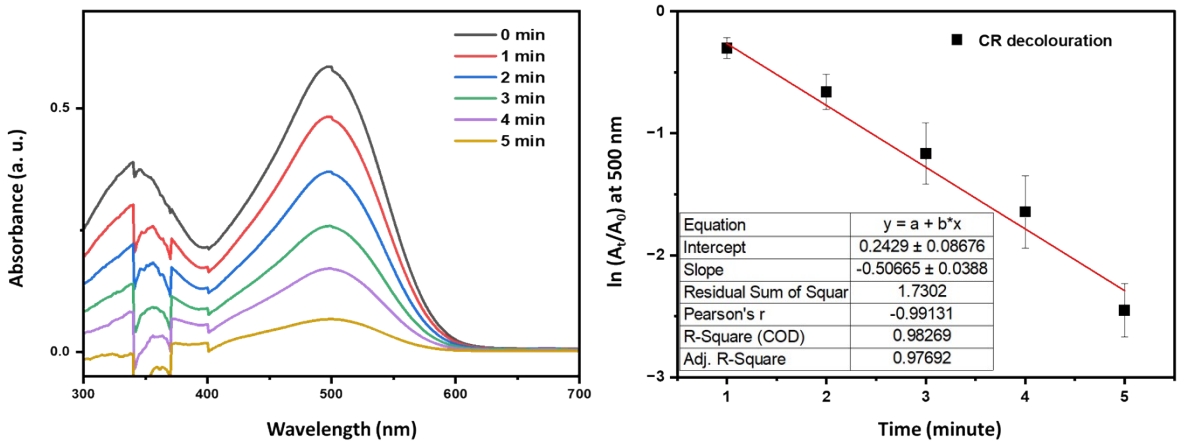

Figure S9: (left) UV-Vis absorption spectra of CR dye solution at different time in presence of Au NPs/Alg-CA material and $NaBH_4$, (right) Rate constant determination for CR degradation.

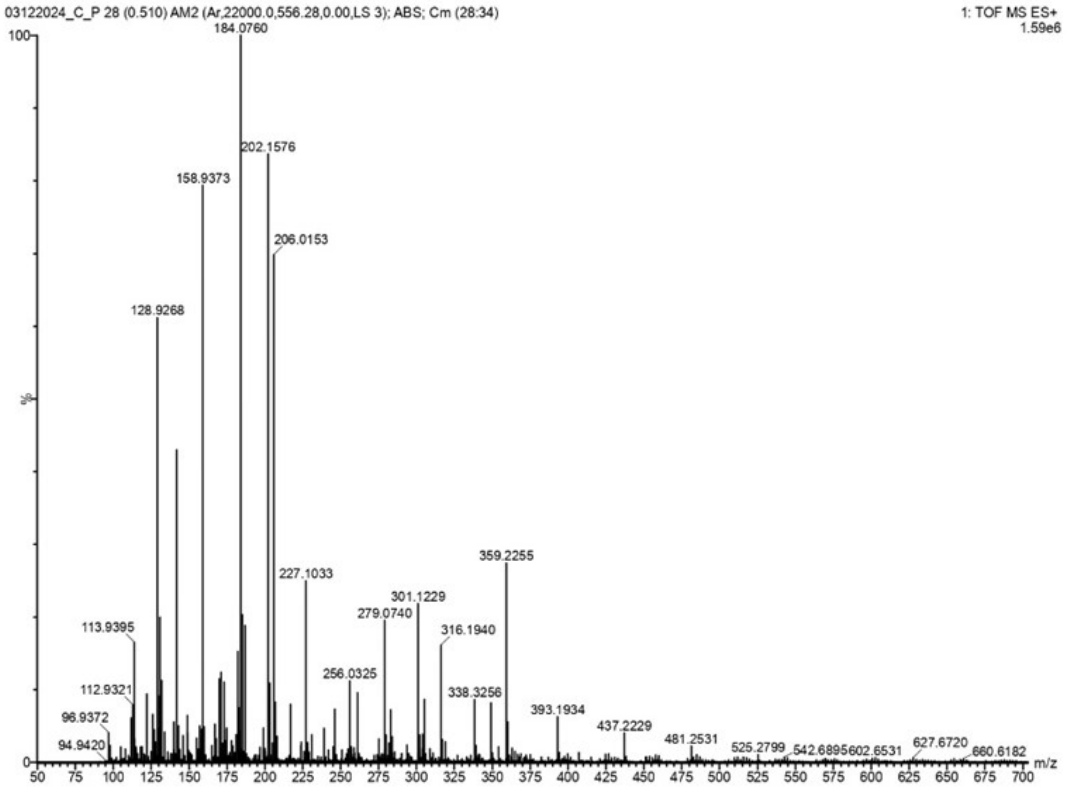

Figure S10: Mass spectrum of the degraded CR solution.

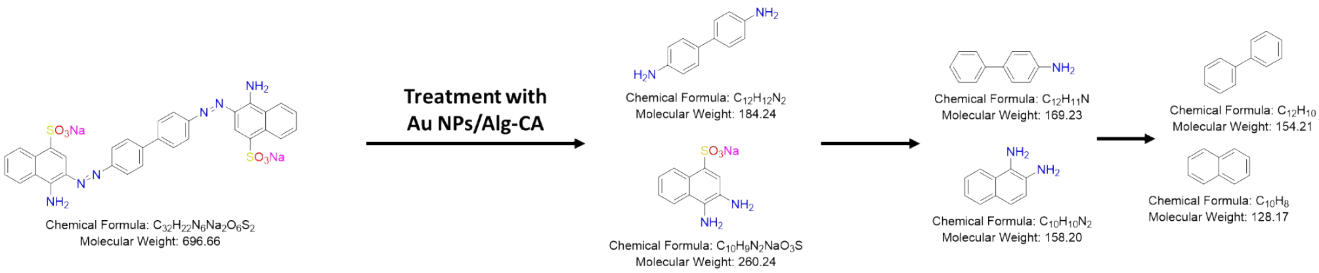

Figure S11: A possible pathway of CR dye degradation.

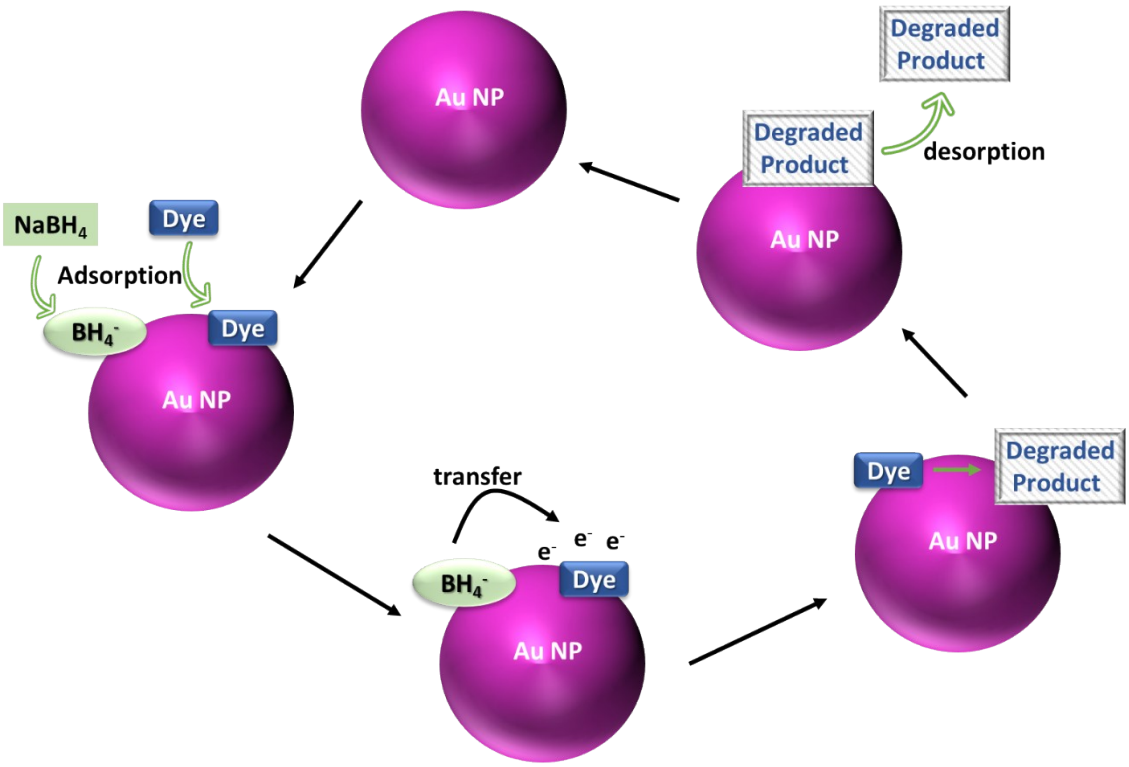

Figure S12: A schematic for the dye degradation on Au NP surface in presence of $NaBH_4$.

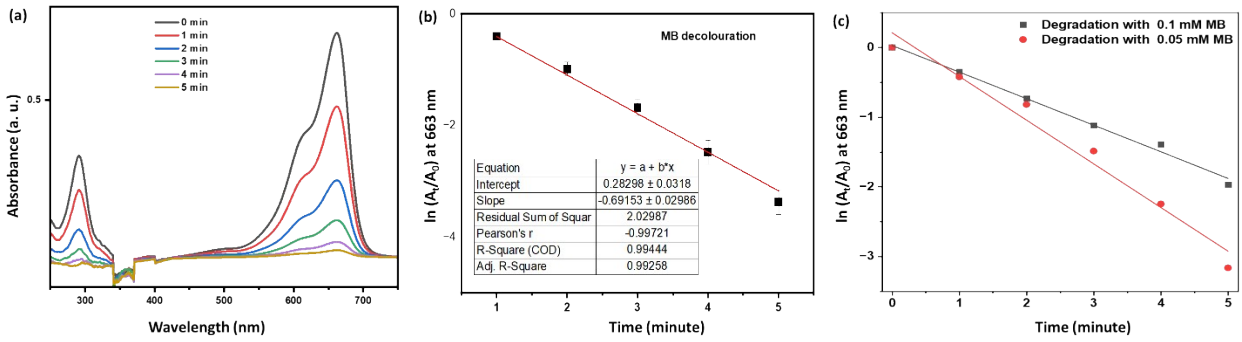

Figure S13: (a) UV-Vis absorption spectra of MB dye solution (0.05 mM) at different time in presence of Au NPs/Alg-CA material and $NaBH_4$, (b) Rate constant determination for MB degradation, (c) MB degradation with different concentration of MB.

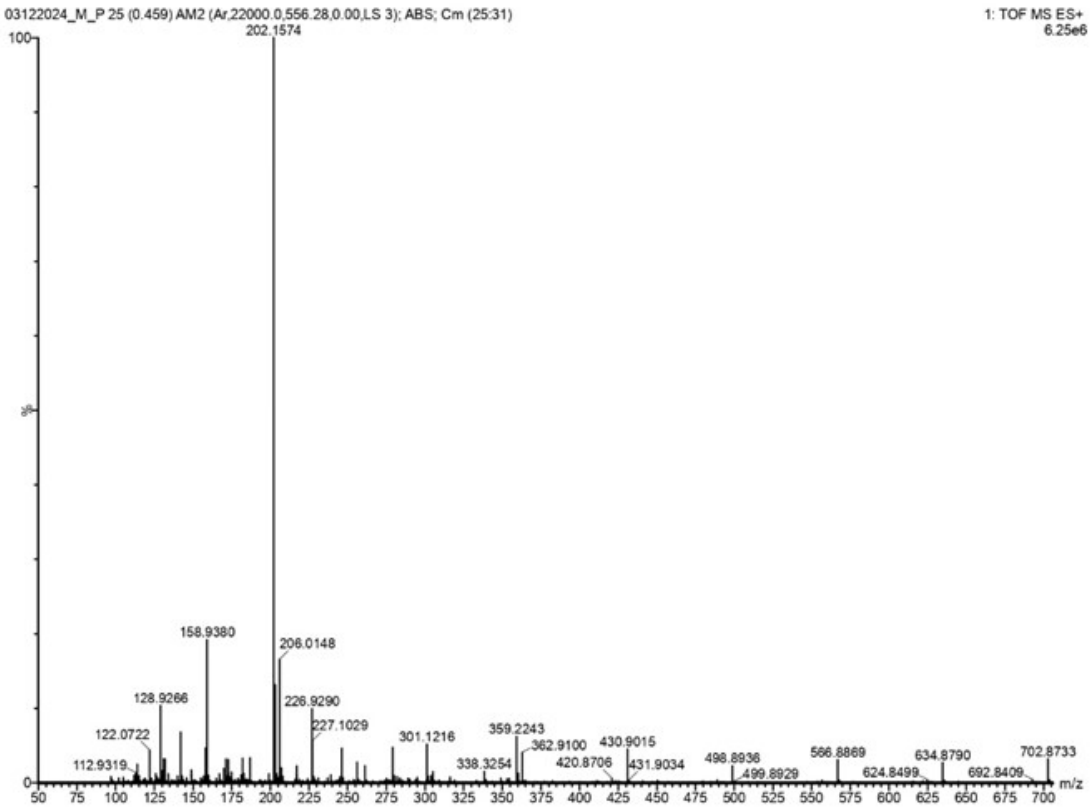

Figure S14: Mass spectrum of the degraded MB solution.

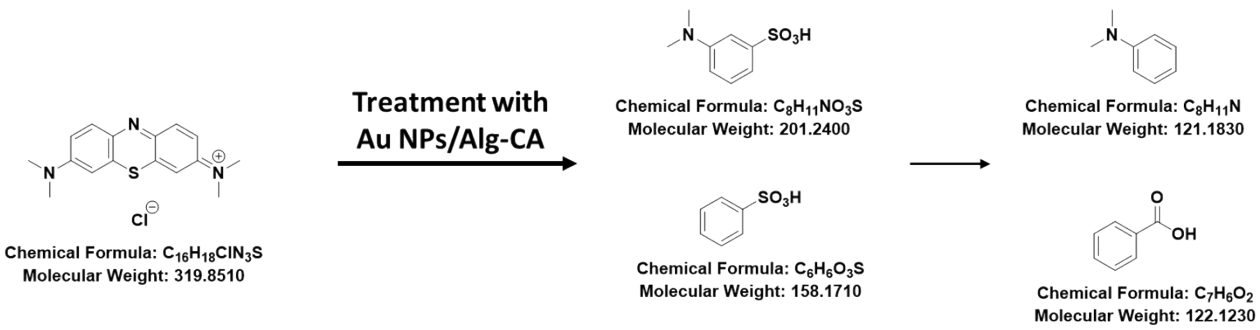

Figure S15: A possible pathway of MB dye degradation with Au NPs/Alg-CA.

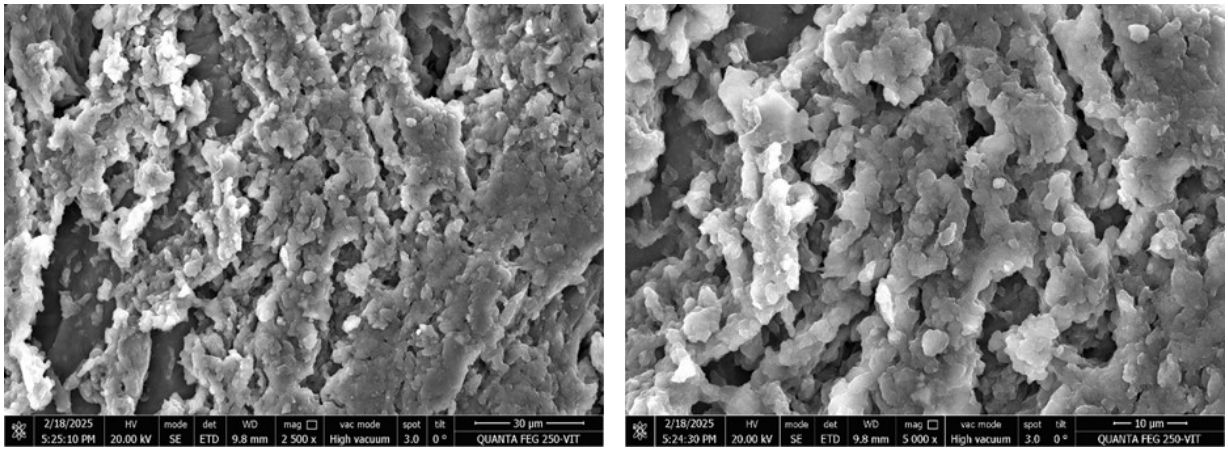

Figure S16: FESEM images of Au NPs/Alg-CA material after 3 consecutive cycles of dye degradation.

Table S1: Comparison of rate constant for CR and MB degradation.

Sr. No.	Catalyst system	Substrate	Rate Constant (k)	Reference
1.	Au NPs by *Bacillus marisflavi*	CR MB	0.2192 Min^{-1} 0.2484 Min^{-1}	N. Y. Nadaf et al.[S1]
2.	Au NPs loaded double network hydrophilic cryogels	CR	0.3653 Min^{-1}	A. Haleem et al.[S2]
3.	Au NPs by turnip leaf extract	MB	0.372 Min^{-1}	K. B. Narayanan et al.[S3]
4.	Au NPs capped by salmalia malabarica gum	CR MB	0.236 Min^{-1} 0.241 Min^{-1}	B. R. Ganapuram et al.[S4]
5.	Au NPs/Alg-Hy	CR MB	0.5066 Min^{-1} 0.6915 Min^{-1}	This work

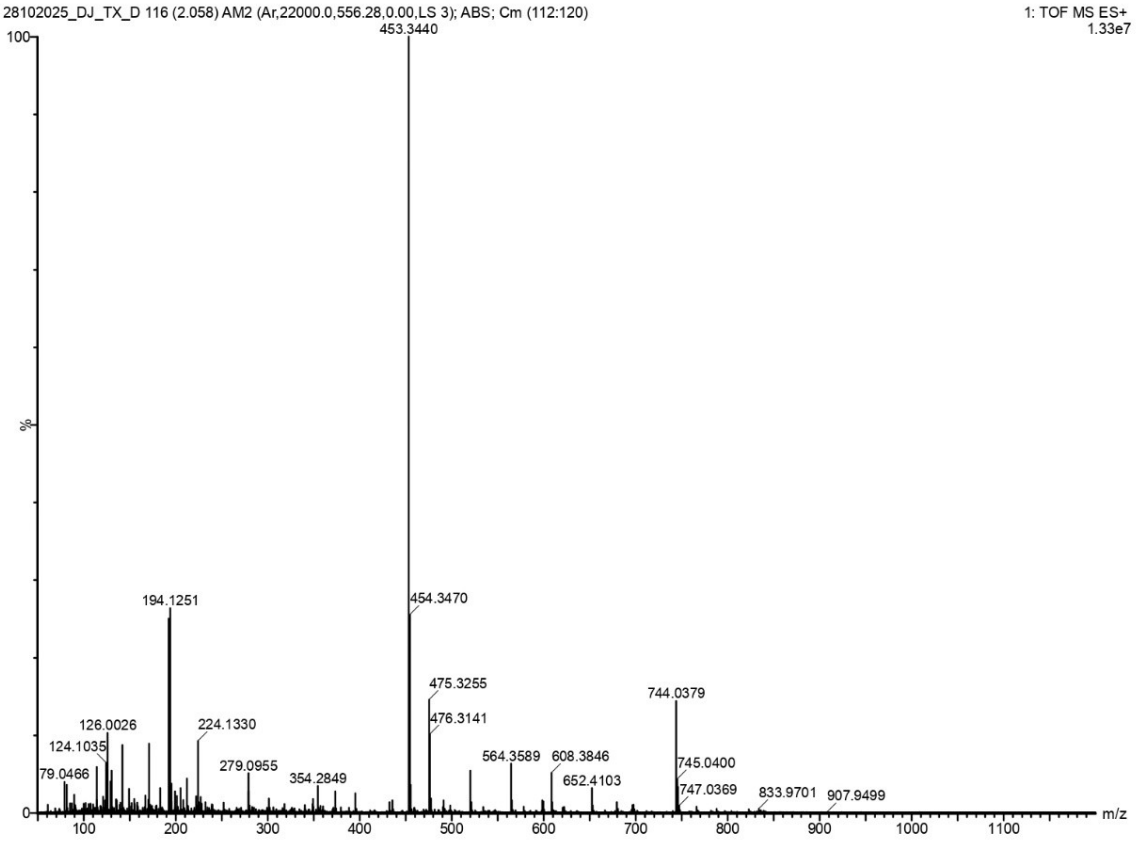

Figure S17: HRMS spectrum of the blue-coloured textile dye solution.

Table S2: Surface charge analysis (Zeta potential) of Au NPs/Alg-CA.

Brookhaven Instruments

Summary Statistics Report

Type	Start Date/Time	Sample ID	Zeta Potential (mV)	Mobility (μ/s)/(V/cm)	RMS Residual
PALS	11-06-2025 14:16:34	AU 4 - 1	-23.61	-1.84	3.5817e-02
PALS	11-06-2025 14:17:14	AU 4 - 2	-21.98	-1.72	2.1412e-02
PALS	11-06-2025 14:17:54	AU 4 - 3	-22.49	-1.76	1.6586e-02
PALS	11-06-2025 14:18:35	AU 4 - 4	-21.56	-1.68	1.7713e-02
PALS	11-06-2025 14:19:15	AU 4 - 5	-18.97	-1.48	3.1767e-02
		Mean:	-21.72	-1.70	2.4659e-02
		Std Err:	0.77	0.06	3.8664e-03
		Std Dev:	1.72	0.13	8.6456e-03

References

S1. N. Y. Nadaf, S. S. Kanase. Biosynthesis of gold nanoparticles by Bacillus marisflavi and its potential in catalytic dye degradation. Arabian journal of chemistry. 2019, 12, 4806-4814. (https://doi.org/10.1016/j.arabjc.2016.09.020)

S2. A. Haleem, S. Chen, J. Pan, H. Weidong. Gamma radiation induced synthesis of double network hydrophilic cryogels at low pH loaded with AuNPs for fast and efficient degradation of

Congo red. Journal of Hazardous Materials Advances. 2023, 10, 100299. (https://doi.org/10.1016/j.hazadv.2023.100299)
S3. K. B. Narayanan, H. H. Park. Homogeneous catalytic activity of gold nanoparticles synthesized using turnip (Brassica rapa L.) leaf extract in the reductive degradation of cationic azo dye. Korean J. Chem. Eng. 2015, 32, 1273-1277. (https://doi.org/10.1007/s11814-014-0321-y)
S4. B. R. Ganapuram, M. Alle, R. Dadigala, A. Dasari, V. Maragoni, V. Guttena. Catalytic reduction of methylene blue and Congo red dyes using green synthesized gold nanoparticles capped by salmalia malabarica gum. Int Nano Lett. 2015, 5, 215–222. (https://doi.org/10.1007/s40089-015-0158-3)