

Supporting Information

N-Doped Carbon Dots Hydrogel from Brewing Waste for Photocatalytic Wastewater Treatment

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DOSY experiment

A DOSY-NMR study was performed to support the ¹H-NMR spectra in the identification of the various signals present in the CDs samples. By assuming ideal spherical structures for the CDs and by comparing with a known reference (the solvent), the Stokes-Einstein equation (Eq. 1) allows to correlate the Diffusion coefficients of the compounds with their hydrodynamic radius.

$$\Delta = (k_B * T) / (6\pi\eta r H) \quad (1)$$

By comparing the different CDs diffusion coefficient (Δ) values, normalized with respect to the solvent, with those of a known reference (p-Toluene sulfonic acid, PTSA), it is possible to correlate the ratio of the diffusion coefficient to the ratio of the radius (r) and to consequently calculate the relative volume (V) and mass (m):

$$\Delta_c / \Delta = r / r_p \quad (2)$$

$$(\Delta_c / \Delta)^3 = (V / V_c) \quad (3)$$

By applying the Graham's law (Eq. 4), it is then possible to correlate the diffusion coefficient to the mass of the analyzed compound and their relative mass (m) is calculated by Eq. 5

$$\Delta = k * (T / m)^{1/2} \quad (4)$$

$$(\Delta_c / \Delta)^2 = m / m_c \quad (5)$$

Finally, by using the Eq. 6, it is possible to estimate the MW.

$$m = m_c * (\Delta_c / \Delta)^2 \quad (6)$$

The volume, mass and MW obtained have to be considered as an indicative value, due to the complex system studied and the deviation from the ideal spherical shape of the carbogenic frameworks.

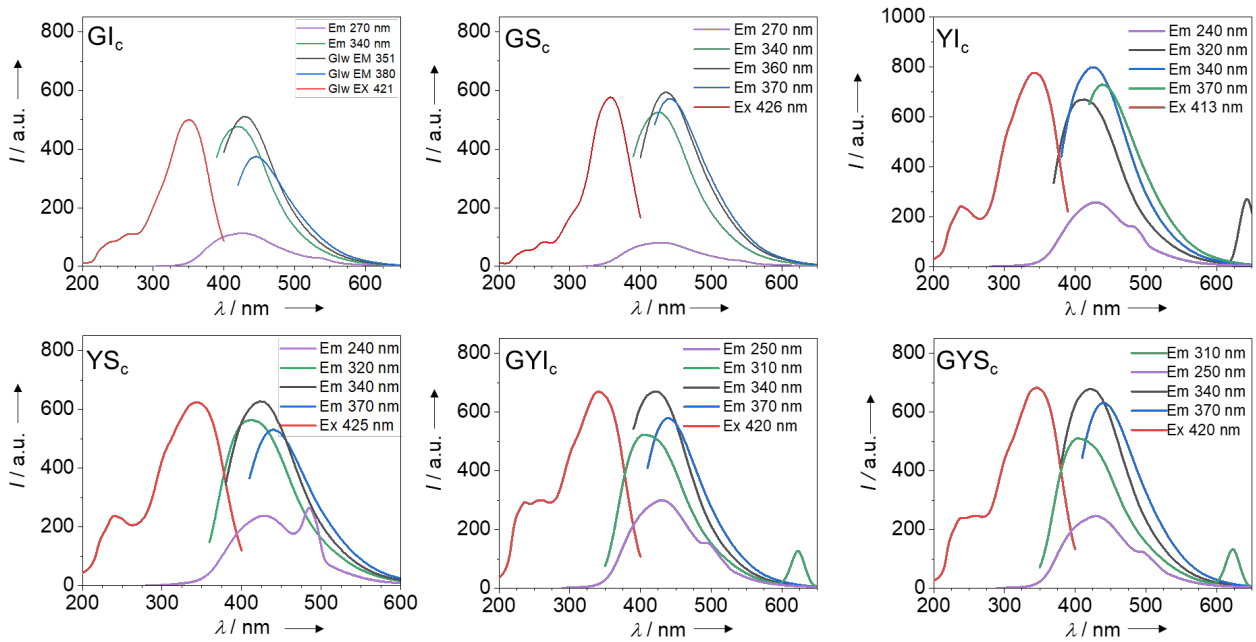


Figure S1. PL and PLE emission of the crude CDs.

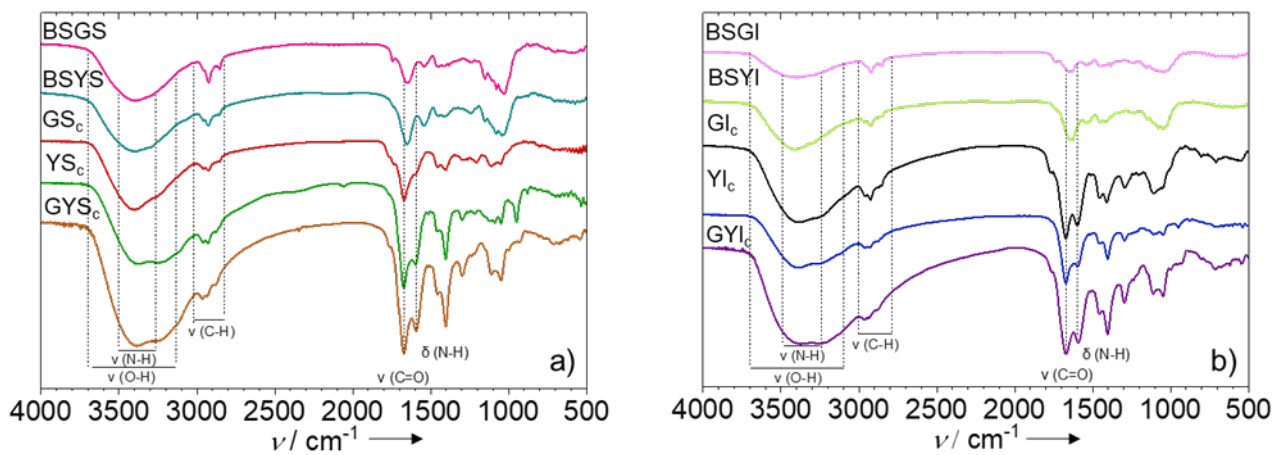


Figure S2. FT-IR of starting materials and crude CDs for Stout (a) and IPA (b) waste.

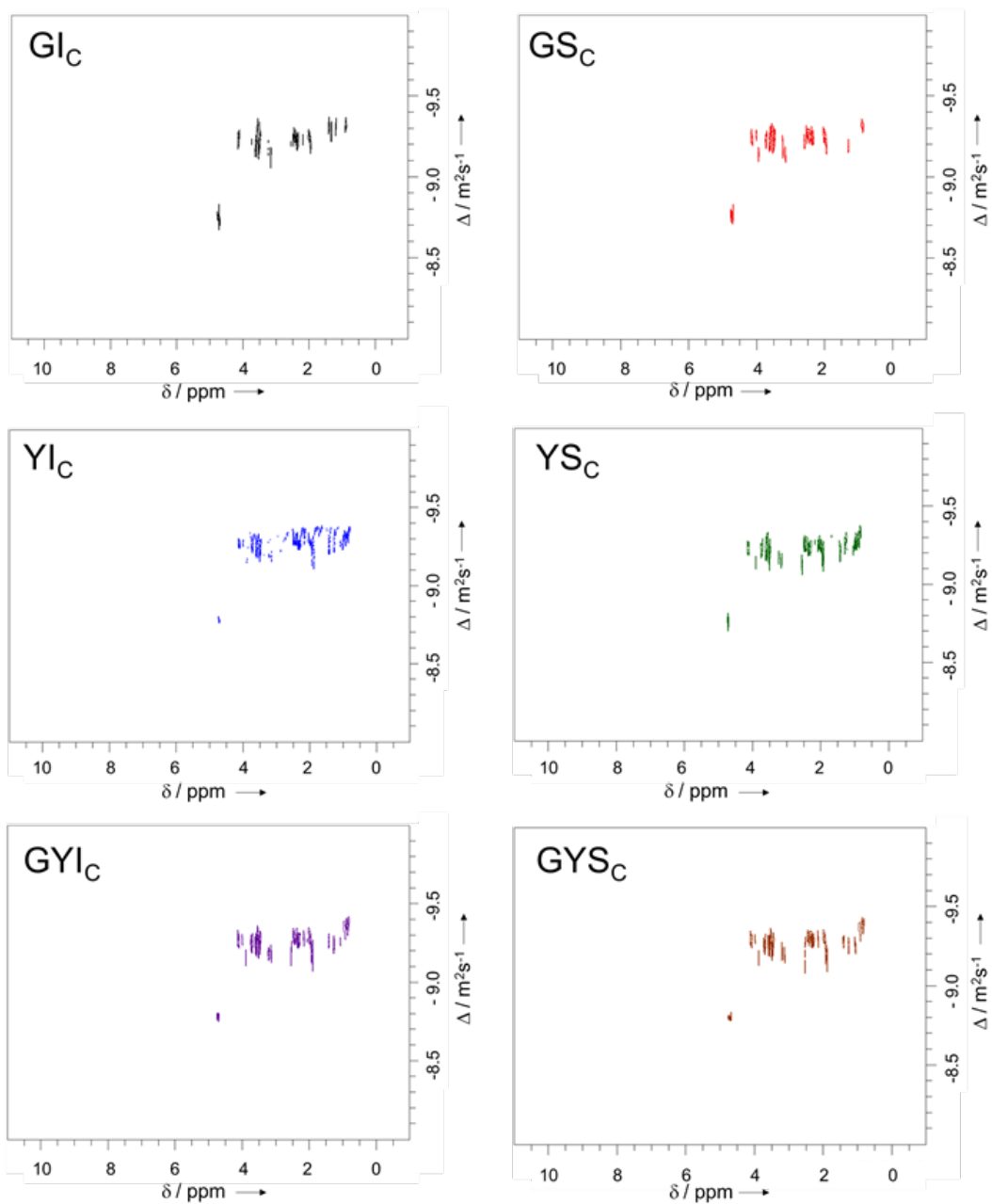


Figure S3. DOSY NMR spectra of crude CDs.

Table S1. DOSY-NMR data for crude CDs samples.

Name	Normalized diffusion coefficient [m ² s ⁻¹]	MW [Da]	Name	Normalized diffusion coefficient [m ² s ⁻¹]	MW [Da]	Name	Normalized diffusion coefficient [m ² s ⁻¹]	MW [Da]
GI_c	0.4348	135.3	YI_c	0.4441	129.7	GYI_c	0.4865	108.1
	0.4124	150.5		0.4145	148.9		0.4421	130.9
	0.34	221.3		0.3798	177.4		0.4061	155.2
	0.2839	317.4		0.34	221.3		0.3764	180.6
GS_c	0.4315	137.4	YS_c	0.4138	149.4	GYS_c	0.3322	231.8
	0.3776	179.5		0.4023	158.1		0.4836	109.4
	0.369	187.9		0.3728	184.1		0.434	135.9
	0.3428	217.8		0.3337	229.8		0.4031	157.4
	0.2979	288.4		0.3728	184.1		0.3762	180.8
							0.3345	228.6

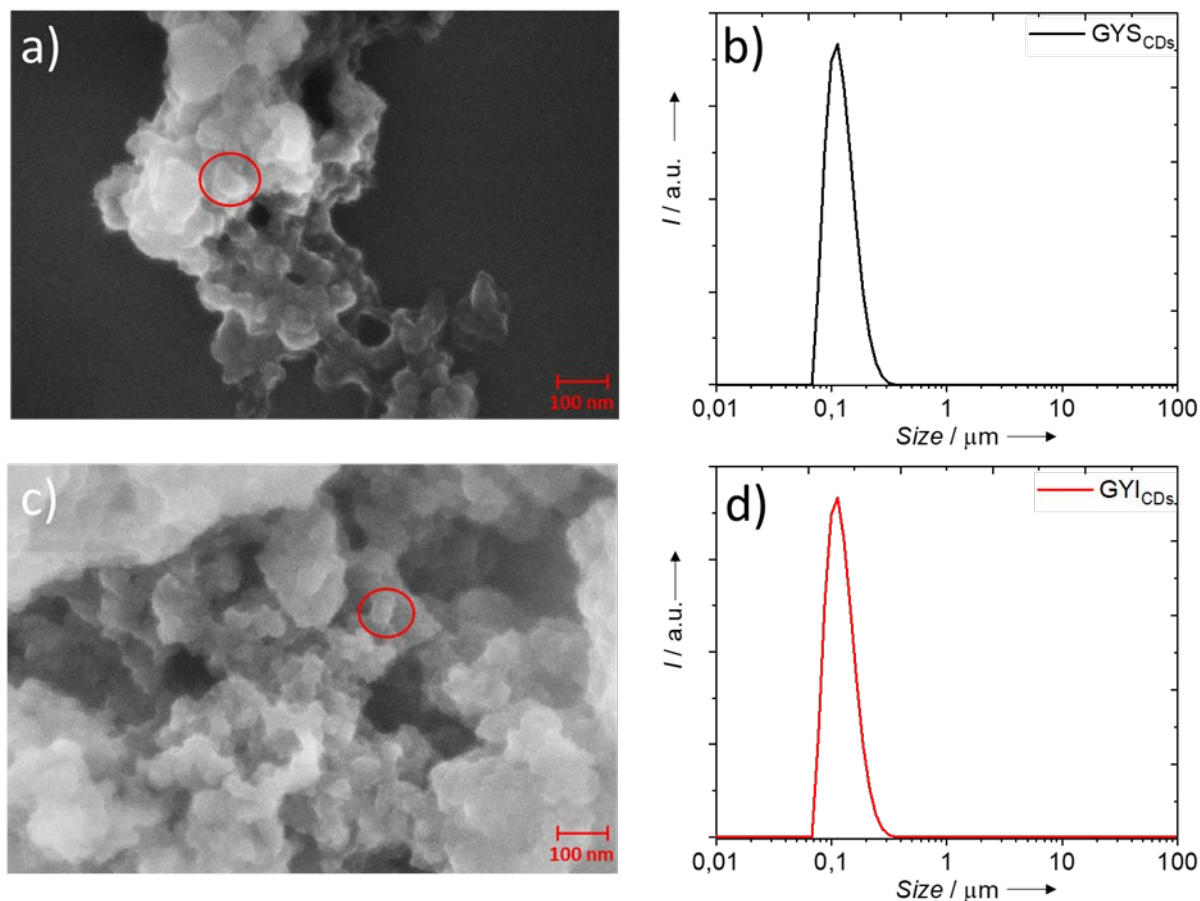


Figure S4. SEM micrographs (a,c) and laser diffraction profiles (b,d) of GYS_{CDs} and GYI_{CDs}.

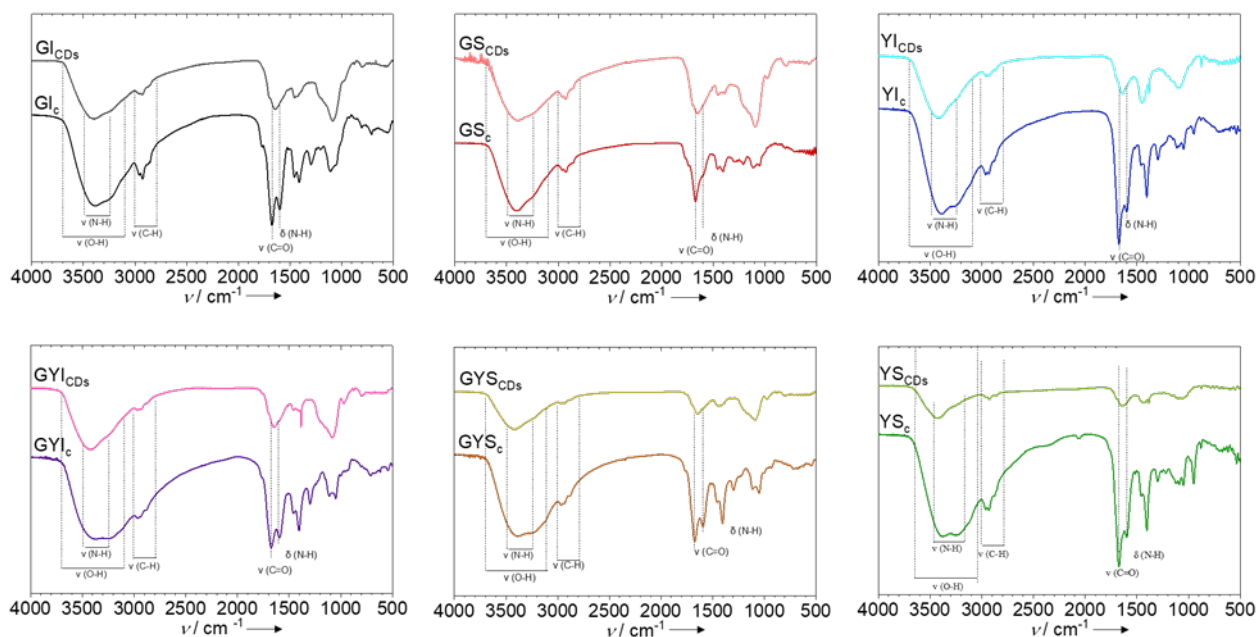


Figure S5. Comparison of FT-IR spectra of crude and dialyzed CDs.

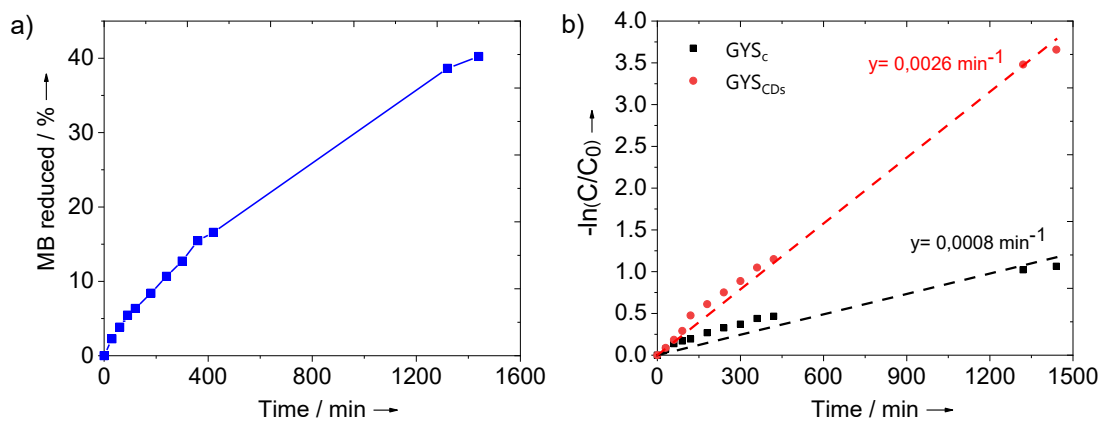


Figure S6. a) Degradation of the sole MB upon UV irradiation (control experiment); b) Degradation rate of MB in the presence of SYS_c and SYS_{CDs} . Dashed lines represent the linear fitting curves for the calculation of the photodegradation specific constants.

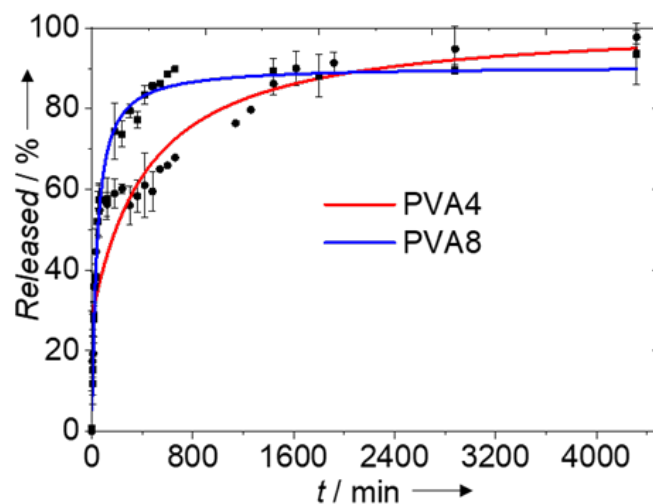


Figure S7. Kinetics of release of fluorophores from PVA4 and PVA8 composite hydrogels.

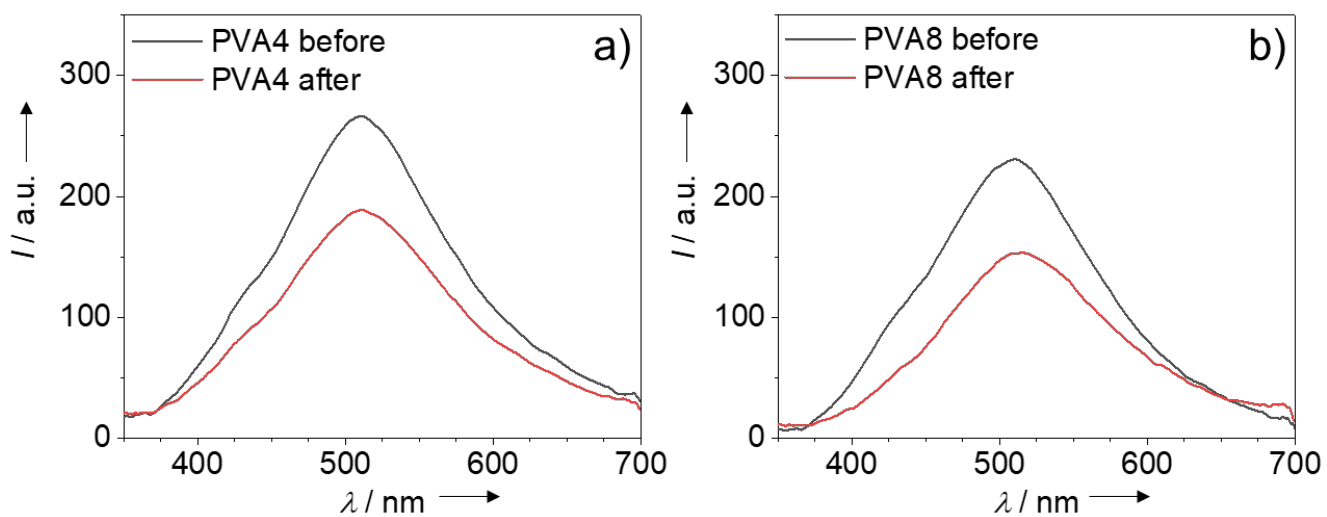


Figure S8. Photoluminescence of PVA4 (a) and PVA8 (b) composites before and after the dialysis treatment.

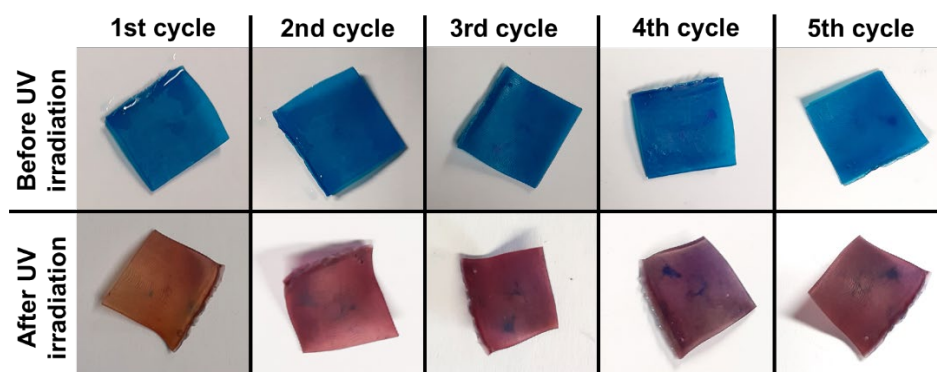


Figure S9. Photographs of PVA4 hydrogels after MB absorption, before and after 24h of UV irradiation. The test was carried out 5 times to evaluate the performances of the photocatalytic system after repeated use.