Adsorption-Assisted Photocatalytic Removal of Melanoidin from Water by a Nitrogen-Rich Covalent Organic Framework

Xuhui Zhang[#,1], Wenju Zhang[#,1], Hui Guo[1], Junyou Shi[1], Dan Zhang[*,1]

[#]These authors contributed equally to this work.

[1]School of Materials Science and Engineering, Beihua University, Jilin City 132013, P. R. China.

Supplementary captions

S1 Materials

S2 Instruments

Fig. S1 FT-IR spectrum (a), XRD pattern (b), XPS survey (c), and high-resolution C 1s (d), O 1s (e), and N 1s (f) spectra of TAPT-TFB COF.

Fig. S2 UV–Vis DRS spectrum (a), band-gap estimation (b), and VB-XPS (c) of TAPT-TFB COF.

Fig. S3 N_2 adsorption–desorption isotherms with pore size distribution (inset) (a) and SEM image (b) of TAPT-TFB COF.

Fig. S4 The adsorption of MD on TAPT-TFB COF under dark conditions.

Fig. S5 IR spectra (a), XRD spectra (b), XPS spectra (c), UV–Vis DRS spectra (d) of TAPT-TFB COF before and after reaction, and N_2 adsorption–desorption measurement (e) after the reaction.
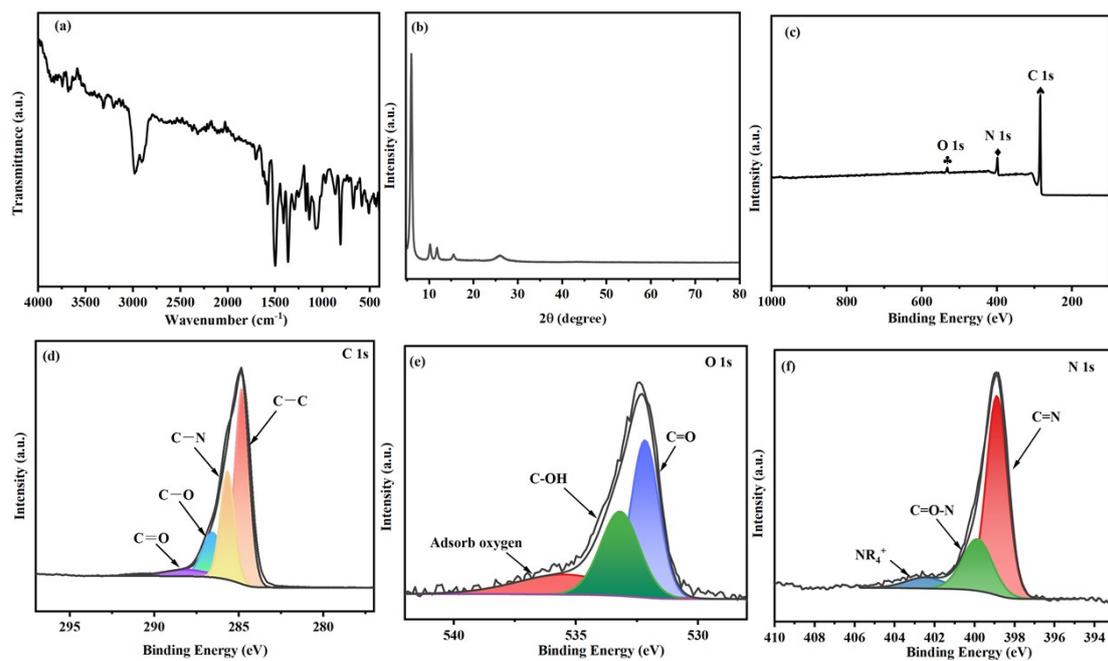
Table S1 Comparison of MD removal performance among different catalysts.
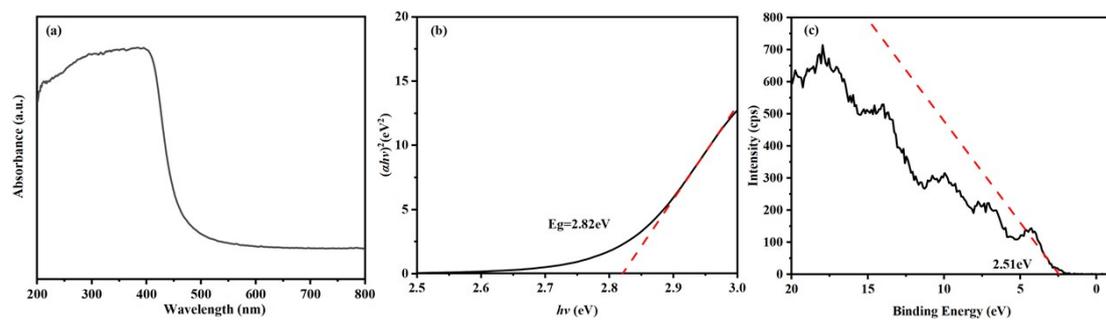
S1 Materials

2,4,6-tris(4-aminophenyl)-1,3,5-triazine (TAPT), triformylbenzene (TFB), and tetrahydrofuran (oxolane) were purchased from Shanghai McLean Biochemical Technology Co., Ltd. Acetic acid, glycine, and glucose (all analytical grade) were obtained from Tianjin Damao Chemical Reagent Factory. Benzoquinone (analytical grade) was purchased from Aladdin. All reagents were used as received without further purification unless otherwise specified.
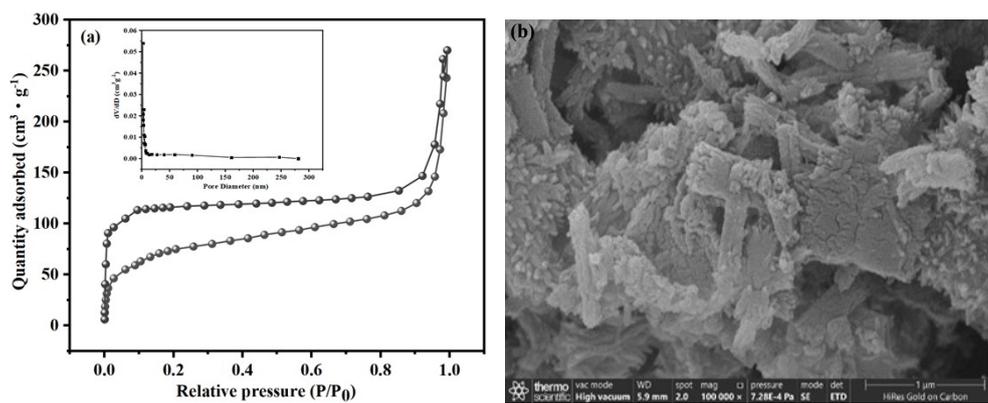
S2 Instruments

The pH meter, PHS-3C, was supplied by Shanghai Yidian Scientific Instrument Co., Ltd. The xenon lamp light (model CEL-HXUV300-T3) was obtained from China Education Au-light. The UV-visible spectrophotometer (722N) was supplied by Shanghai Youke Instrument Co., Ltd. The physicochemical properties of the synthesized materials were comprehensively characterized using a range of analytical techniques. Surface functional groups were identified by Fourier transform infrared spectroscopy (FT-IR, Shimadzu IRAffinity-1S) in the 400–4000 cm^{-1} range. Crystallinity and phase purity were examined using X-ray diffraction (XRD, Shimadzu XRD-6100) with a 2θ scanning range of 5°–90° at 40 kV and 40 mA. Surface chemical composition and elemental valence states were analyzed by X-ray photoelectron spectroscopy (XPS, Axis Supra) using a monochromated Al Kα source (hν = 1486.6 eV), with C 1s (284.8 eV) as the reference under ultra-high vacuum (< 1×10^{-8} Pa). Optical properties were assessed by UV–visible diffuse reflectance spectroscopy (UV–Vis DRS, Shimadzu UV-3600 Plus) in the 200–800 nm range. Specific surface area and pore size distribution were determined using nitrogen adsorption–desorption isotherms (V-Sorb 2800) via the Brunauer–Emmett–Teller (BET) method, following degassing at 80 °C for 240 min and testing at -196 °C with liquid nitrogen. Surface morphology and microstructural characteristics were observed using scanning electron microscopy (SEM, Gemini Sigma 360), equipped with an Xplore 30 energy-dispersive X-ray spectroscopy (EDS) detector.
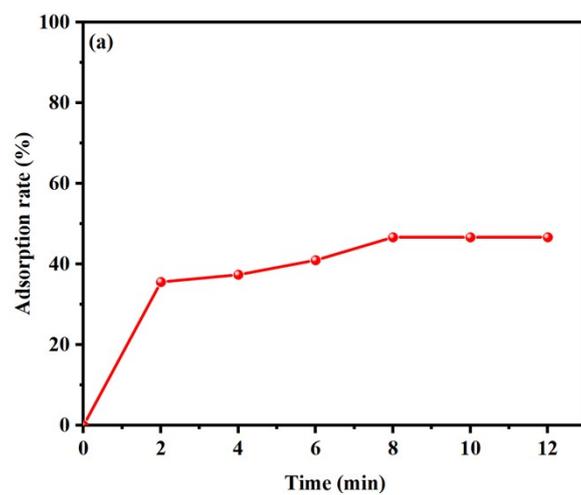
Fig. S1 FT-IR spectrum (a), XRD pattern (b), XPS survey (c), and high-resolution C 1s (d), O 1s (e), and N 1s (f) spectra of TAPT-TFB COF.
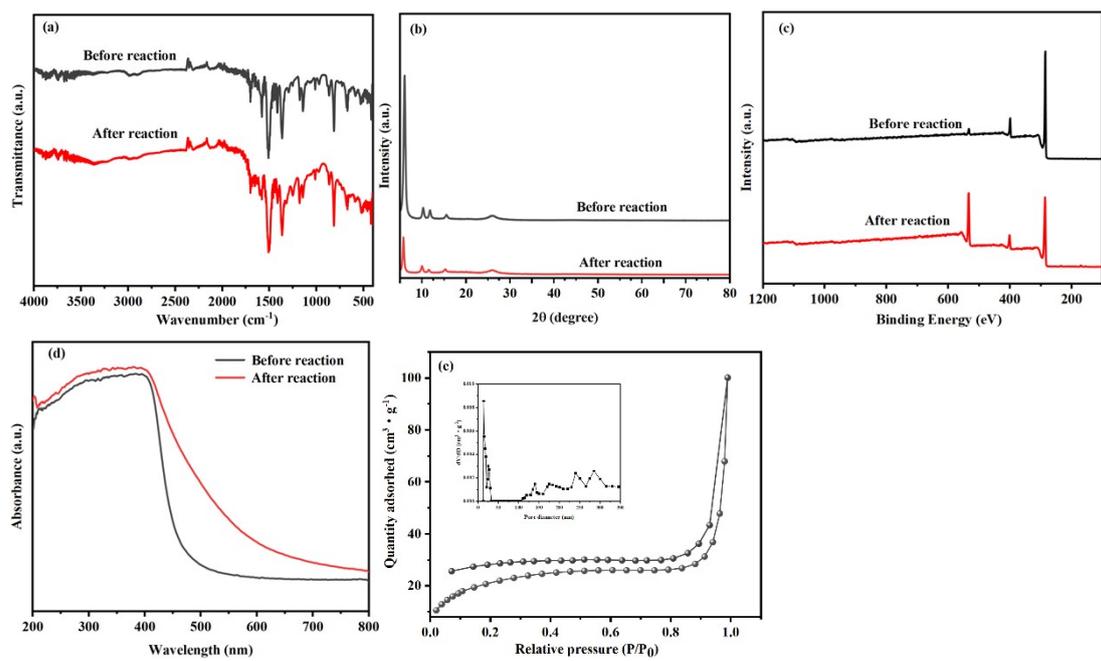
Fig. S2 UV–Vis DRS spectrum (a), band-gap estimation (b), and VB-XPS (c) of TAPT-TFB COF.

Fig. S3 N_2 adsorption–desorption isotherms with pore size distribution (inset) (a) and SEM image (b) of TAPT-TFB COF.

Fig. S4 The adsorption of MD on TAPT-TFB COF under dark conditions.

Fig. S5 IR spectra (a), XRD spectra (b), XPS spectra (c), UV–Vis DRS spectra (d) of TAPT-TFB

COF before and after reaction, and N₂ adsorption–desorption measurement (e) after the reaction.

Table S1 Comparison of MD removal performance among different catalysts

Catalysts	Concentration of MD (g/L)	Catalyst-to-MD concentration ratio (C_{catal}: C_{MD})	pH	Time (h)	Removal rate (%)	References
MoO_3-TiO_2	0.03	83: 1	8	2	70.0	[7]
TiO_2	0.01	27: 1	4	12	74.9	[6]
ZnO	0.01	27: 1	10	12	79.6	[6]
Glass fibers & ZnO-SnO_x-nZVI	0.7	36: 1	6	4	97.3	[28]
TAPT-TFB COF	0.4	5: 8	4	1.5	90.0	this work