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Engineering Fe-doped highly oxygenated solvothermal carbon from glucose based eutectic system as active microcleaner and efficient carbocatalyst

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Table S1. Sample Coding of prepared samples with different reaction conditions

Sl. No.	Precursors	Reaction Condition	Code
01	EM + 0.5M $FeSO_4$	05 hours, 180 ^oC	STC-1
02	EM + 0.5M $FeSO_4$	05 hours, 200 ^oC	STC-2
03	EM + 0.5M $FeSO_4$	05 hours, 220 ^oC	STC-3
04	EM + 0.5M $FeSO_4$	10 hours, 200 ^oC	STC-4
05	EM + 0.5M $FeSO_4$	15 hours, 200 ^oC	STC-5
06	EM only	05 hours, 200 ^oC	STC-6
07	Glucose + 0.5M $FeSO_4$	05 hours, 200 ^oC	STC-7

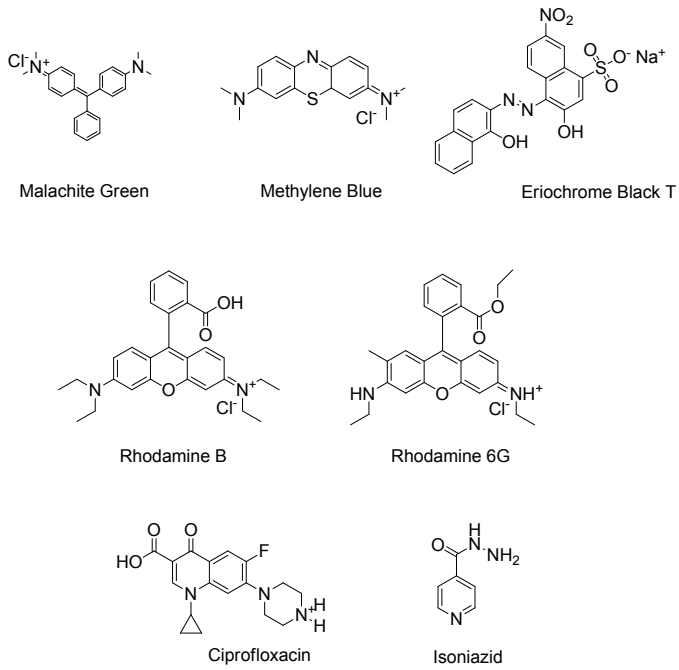

Figure S1. Chemical structures of all the dyes and drugs used in the present study.

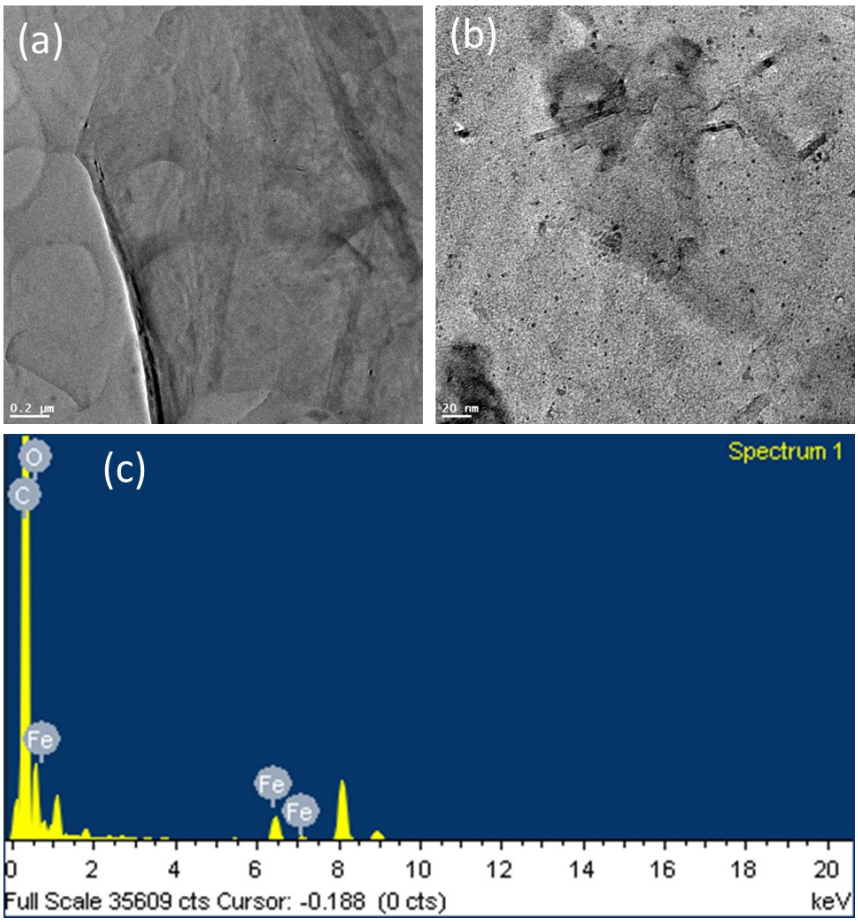

Figure S2: TEM images (a-b) and EDX spectra (c) of STC-2

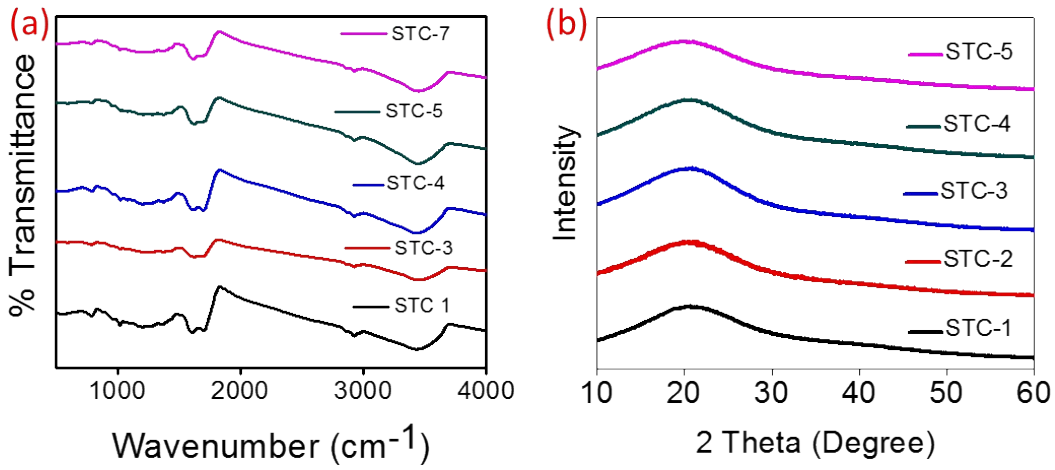

Figure S3: (a) FT-IR spectra and (b) XRD spectra of prepared solvothermal carbons.

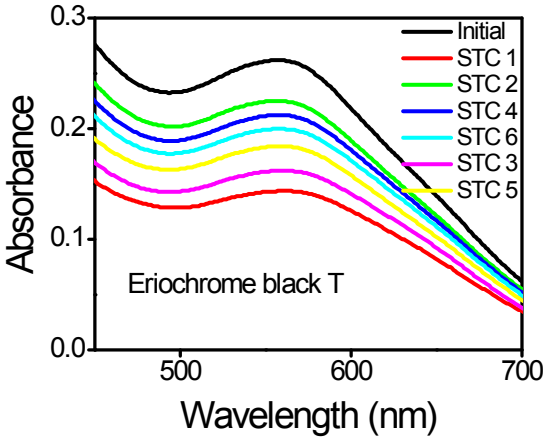

Figure S4. UV spectra showing performance of all prepared microcleaners for EBT obtained through batch adsorption method.

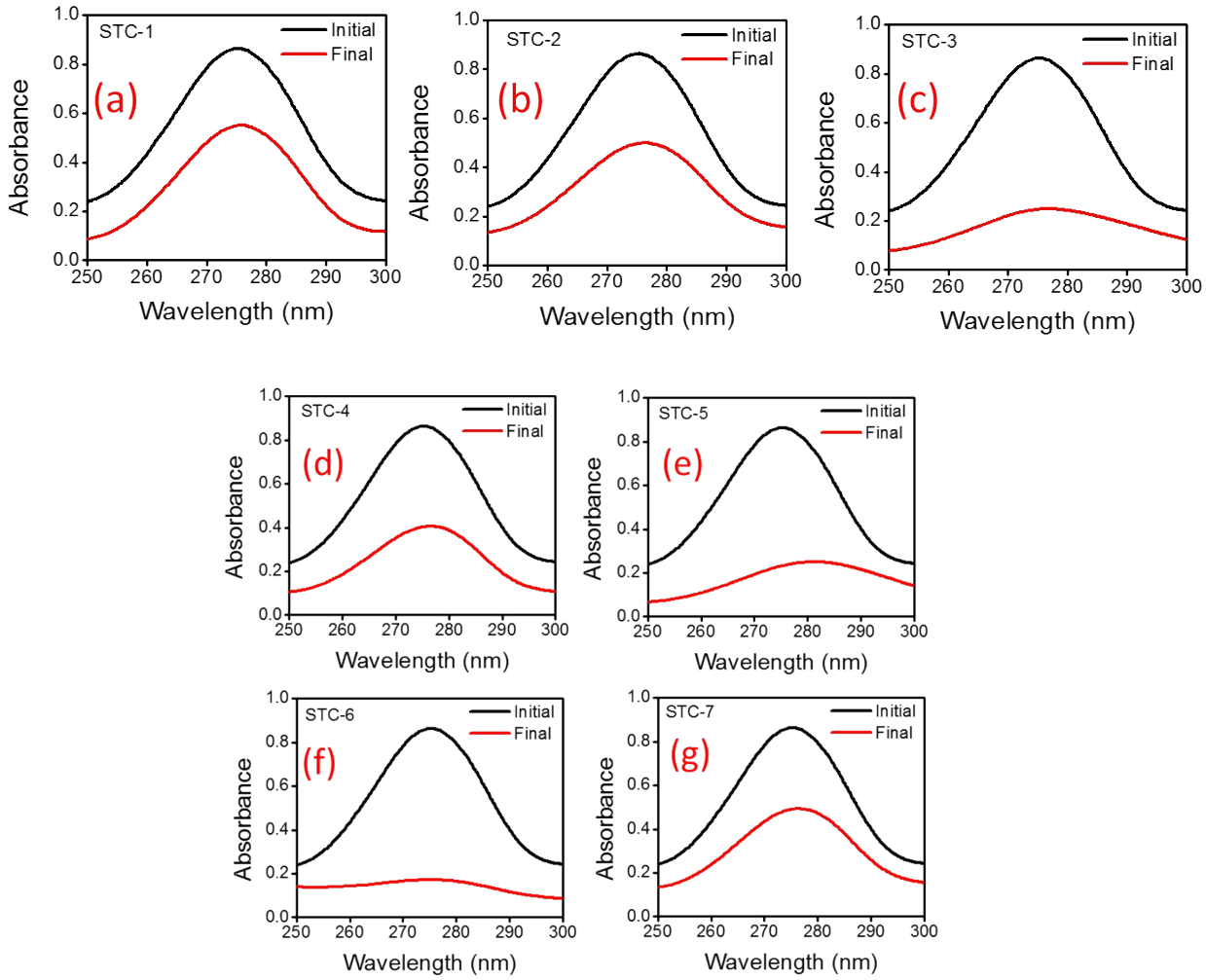

Figure S5. UV spectra showing performance of all prepared microcleaners STC 1-7 (a-g respectively) for Ciprofloxacin drug.

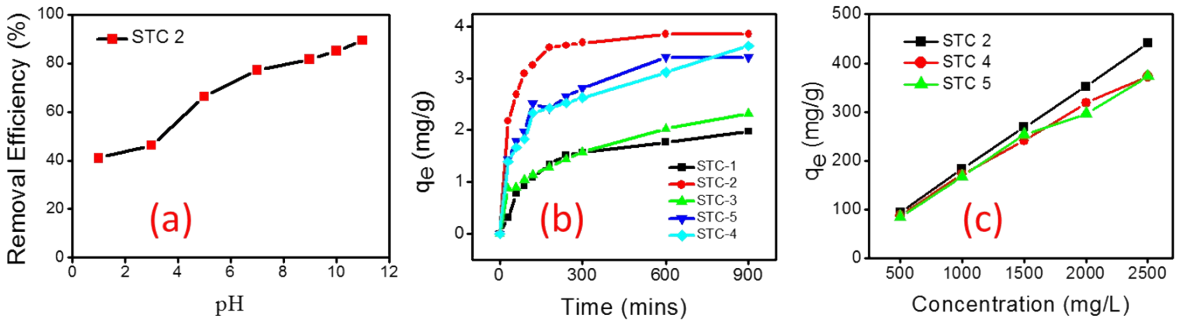

Figure S6. (a) Effect of initial solution pH on the adsorption of MG onto the material STC-2 microcleaner, (b) Results of time dependent study carried out using microcleaners prepared at different reaction time and temperature, (c) Effect of initial MG dye concentration on the adsorption onto the STC-2, STC-4 and STC-5 microcleaners.

Adsorption Isotherm

Langmuir isotherm is based on the assumption that adsorption happens at identical adsorption sites within a homogeneous adsorbent surface, which can be given by Eq. (1)[1]

$$\left(\frac{C_e}{q_e}\right) = \left(\frac{1}{q_m.K_L}\right) + \left(\frac{C_e}{q_m}\right) \qquad \text{_____(1)}$$

Where, q_m (mg/g) represents the maximum adsorption capacity, and K_L (L/mg) is the equilibrium constant related to adsorption energy. On the other hand, Freundlich isotherm is based on the assumption of heterogeneous surface energy. The expression can be given by the following Eq. (2)[1]

$$\ln q_e = \ln K_F + \left(\frac{\ln C_e}{n}\right) \qquad \text{_____(2)}$$

Here, K_F and n are Freundlich constants related to adsorption capacity and adsorption tendency, respectively. n gives an indication of how favourable the adsorption process, while the value of 1/n is indicative of the relative energy distribution on the adsorbent surface and K_F ($mg^{1-1/n}\ L^{1/n}\ g^{-1}$) is defined as the adsorption or distribution coefficient.

For the isotherm studies, drug concentration of 500 mg/L – 2500 mg/L was chosen with 50 mg material. Using above relations, the fitted adsorption isotherms (Figure S6) for the two selected models. All model equilibrium isotherm constants and correlation coefficients

obtained from linear fits of Langmuir and Freundlich isotherms were calculated and illustrating that the correlation coefficient of the Freundlich model (R^2 = 0.995) is higher than that of the Langmuir model, indicating that the adsorption of MG onto adsorbents are fitted by the Freundlich isotherm reasonably better.

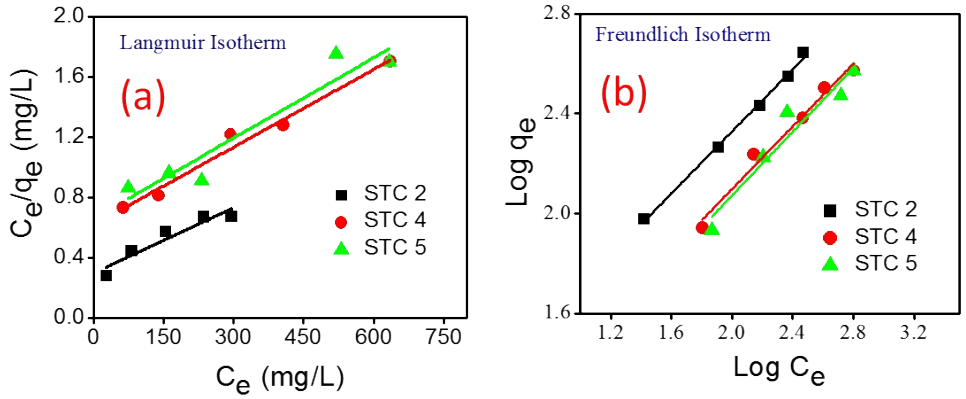

Figure S7. (a) Langmuir and (b) Freundlich adsorption isotherm of MG adsorbed on to the microcleaners prepared at different reaction time respectively.

Table S2. Removal performance of chemical hazardous molecules through material bed made using 50 mg of STC-2 active microcleaner.

Sl. No.	Material	Synthesis	q_{max} (mg g^{-1})	Ref.
1	Norit	Commercial	42	2
2	fructose + LiCl-$ZnCl_2$ salt mixture	Solvothermal treatment 180 ℃	83	2
3	Graphene/Fe_3O_4 hybrids	Hydrothermal treatment at 180°C for 6 h	73.26	3
4	Carbon supported Montmorillonite clay	Hydrothermal treatment at 180°C for 6 h	194.2	4
5	Amino-functionalized attapulgite clay nanoparticle	Hydrothermal treatment at 180 °C for 24 h	215.73	5
6	STC-2	Solvotherma treatment 200 °C, 5h	689.7	Present Work

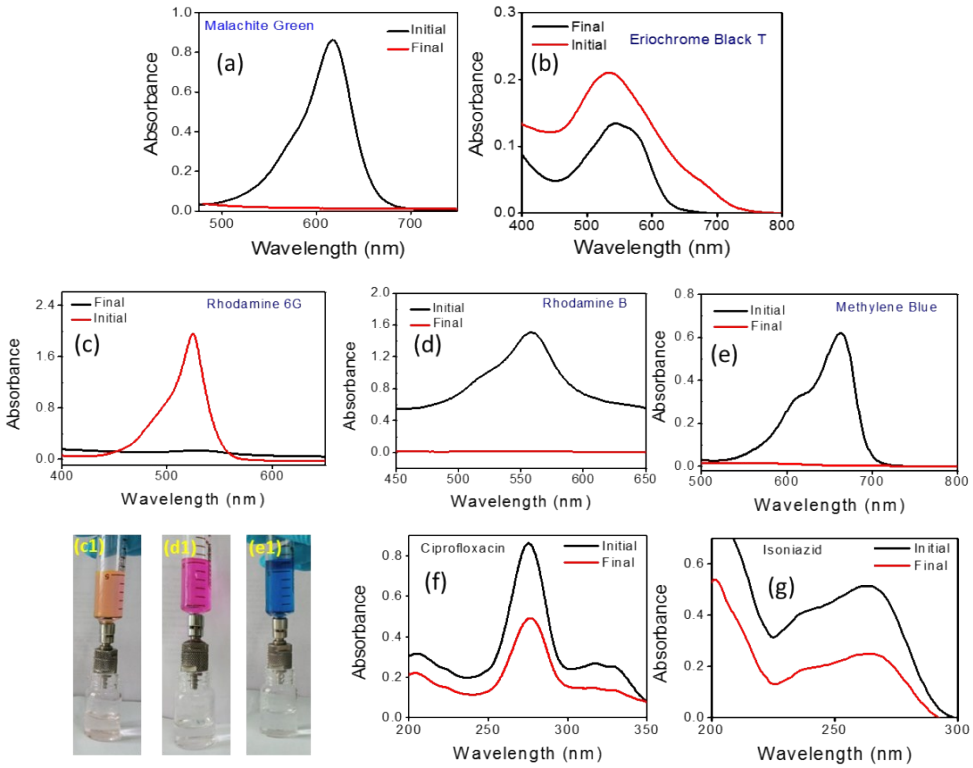

Figure S8. UV spectra showing the performance of STC-2 microcleaners for the removal of (a) MG and (b) EBT, (c) Rh 6G, (d) Rh B, and (e) MB dyes removal where as c1, d1 and e1 showing digital photograph of filtration setup with >99% pollutant removed permeate and then, UV spectra for Cpf (f) and Isoniazid (g) drugs removed through membrane filtration method.

Table S3. Removal performance of chemical hazardous molecules through material bed made using 50 mg of STC-2 active microcleaner.

Organic Pollutant	Nature of substance	Concentration	Flux (L h^{-1} m^{-2})	Rejection
Malachite Green	Cationic Dye	20 ppm, 5mL	602.87	99.9
Rhodamine B	Cationic Dye	20 ppm, 5mL	567.06	98.3
Rhodamine 6G	Cationic Dye	20 ppm, 5mL	584.42	99.6
Methylene Blue	Cationic Dye	20 ppm, 5mL	550.70	96.6
Ciprofloxacin	Cationic Drug	20 ppm, 5mL	590.44	59.63
Isoniazid	Neutral Drug	20 ppm, 5mL	545.45	48.78
Eriochrome Black T	Anionic Dye	10 ppm, 5mL	615.84	19.62

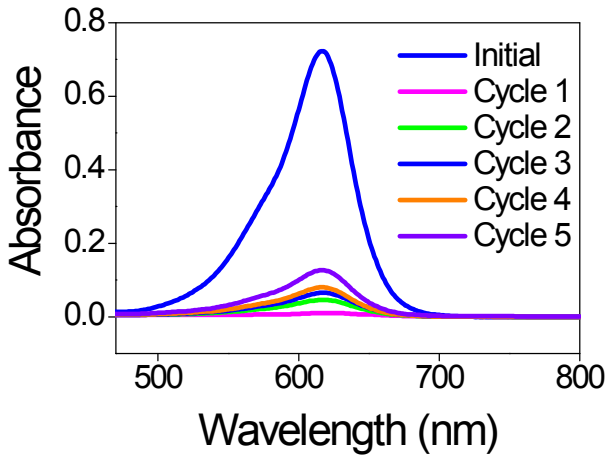

Figure S9: UV-vis spectra obtained during recycle study using membrane like filtration method for MG dye from STC-2 material

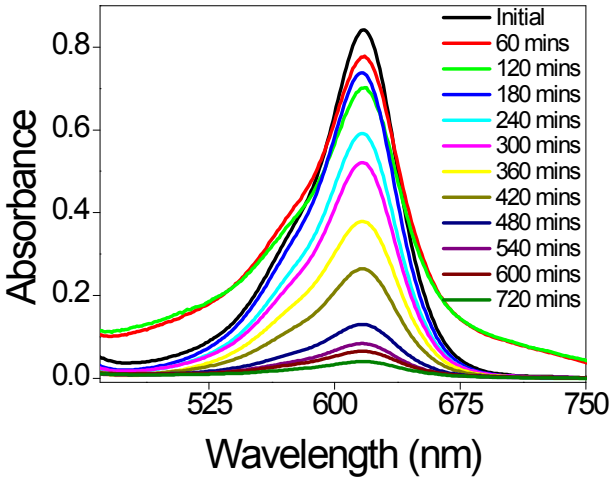

Figure S10: UV-vis spectra of degradation of MG dye at different time intervals.

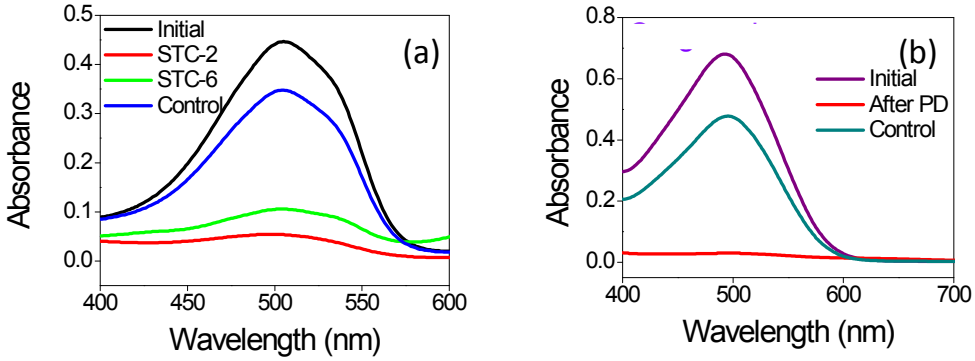

Figure 11: UV-vis spectra obtained after photocatalytic degradation of (a) methyl orange using STC-2, STC-6 material and in control condition (b) congo red using STC-2 material and in control condition

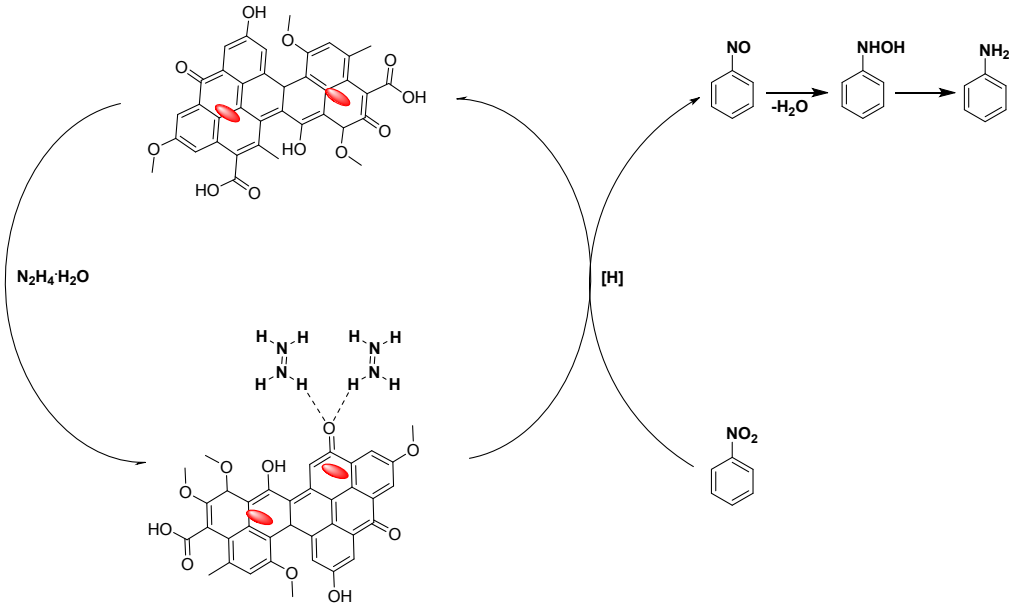

Figure S12. Plausible mechanism for carbocatalysis using prepared STCs.[6]

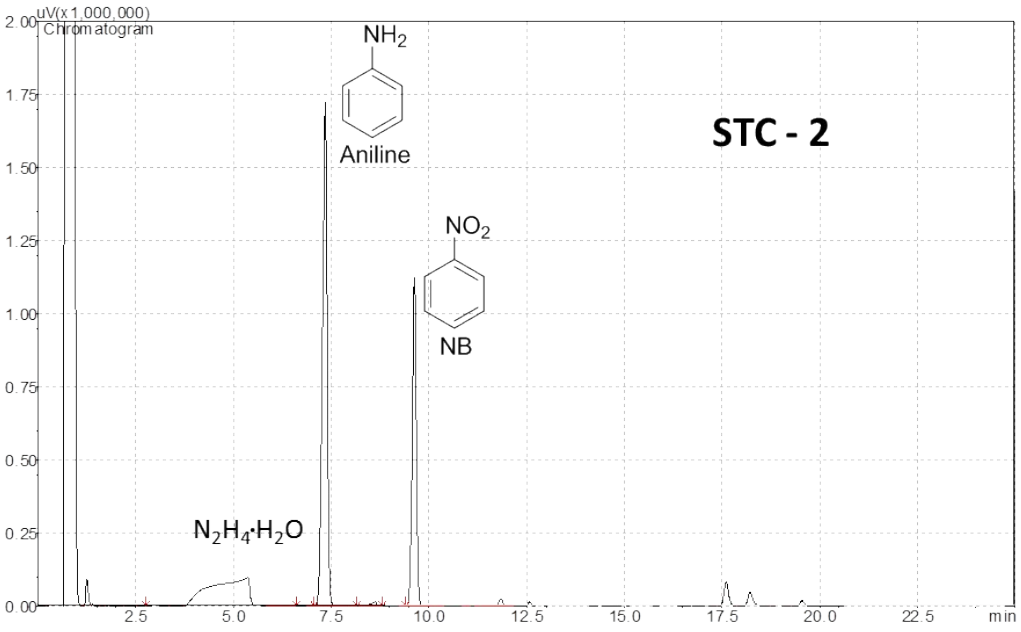

Figure S13. GC chromatogram for reaction mixture treated with STC 2

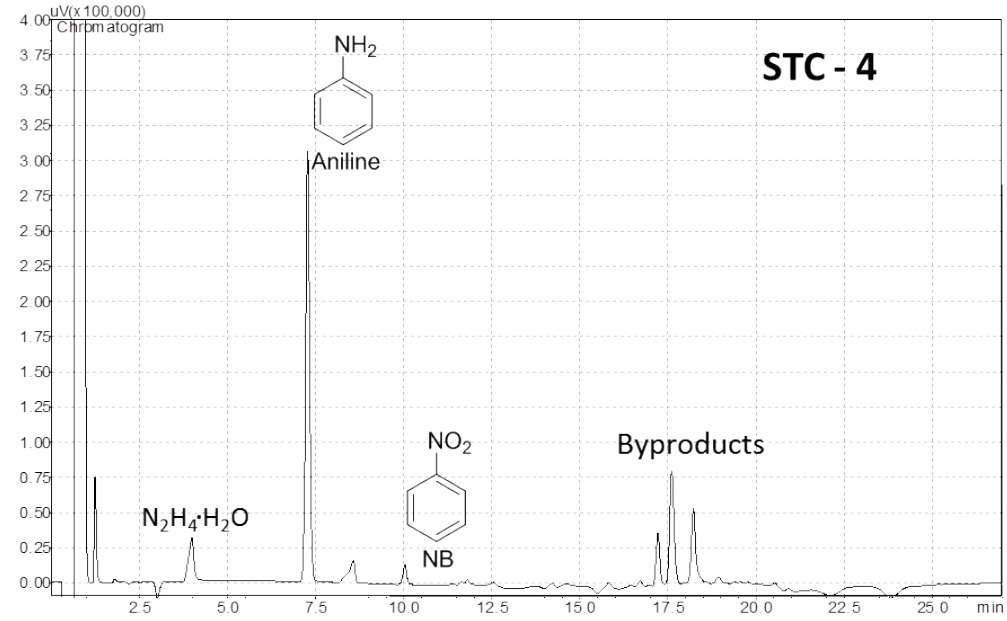

Figure S14. GC chromatogram for reaction mixture treated with STC 4

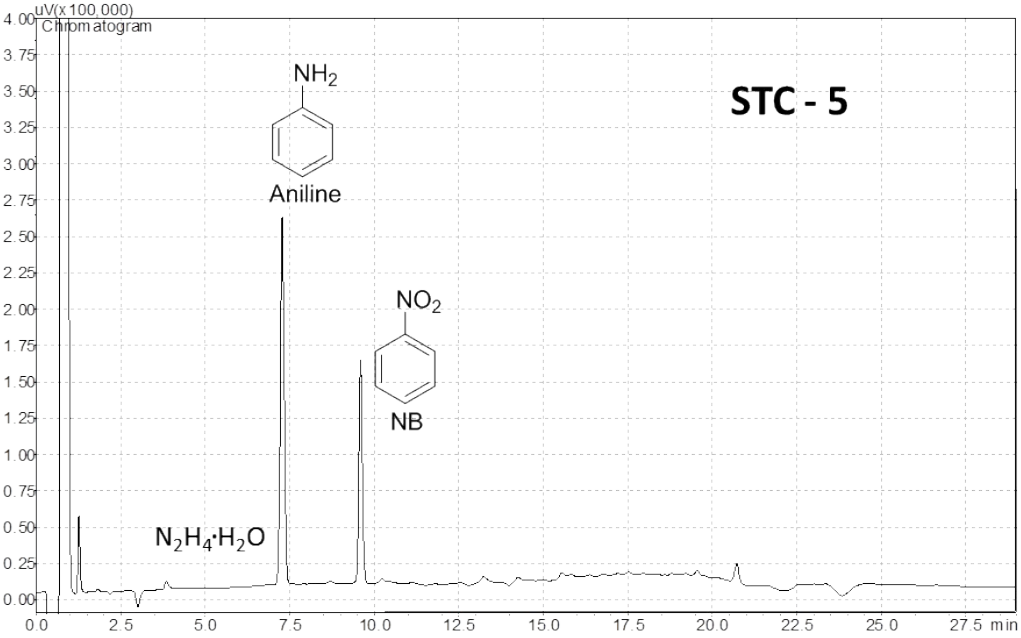

Figure S15. GC chromatogram for reaction mixture treated with STC 5

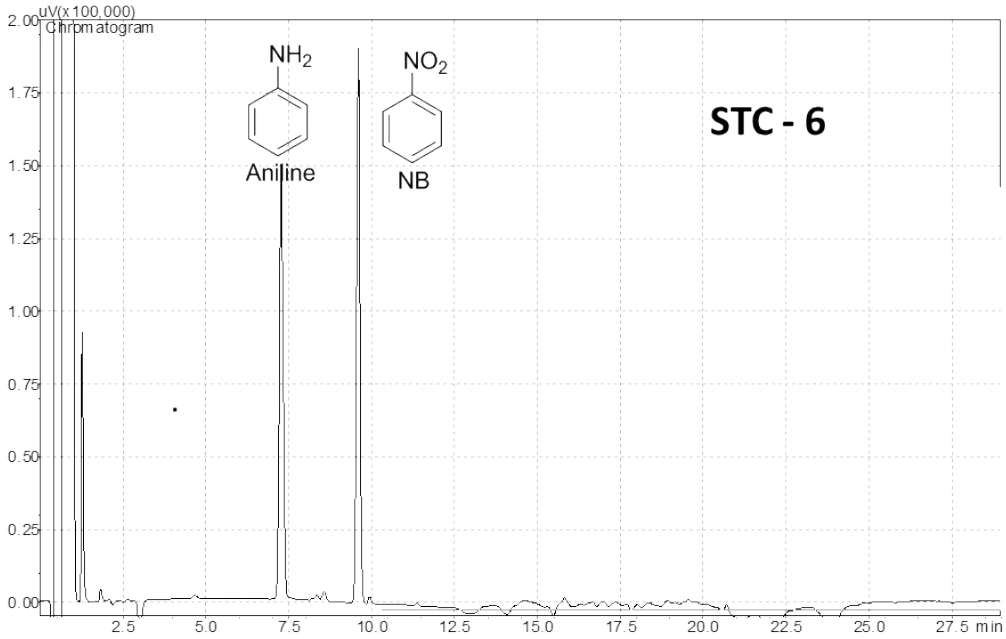

Figure S16. GC chromatogram for reaction mixture treated with STC 63

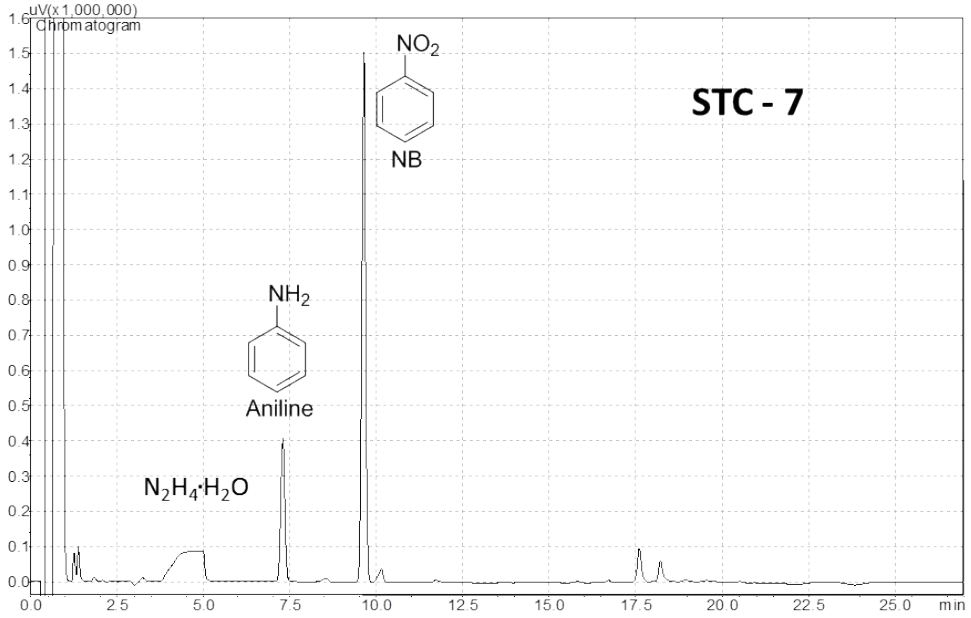

Figure S17. GC chromatogram for reaction mixture treated with STC 7

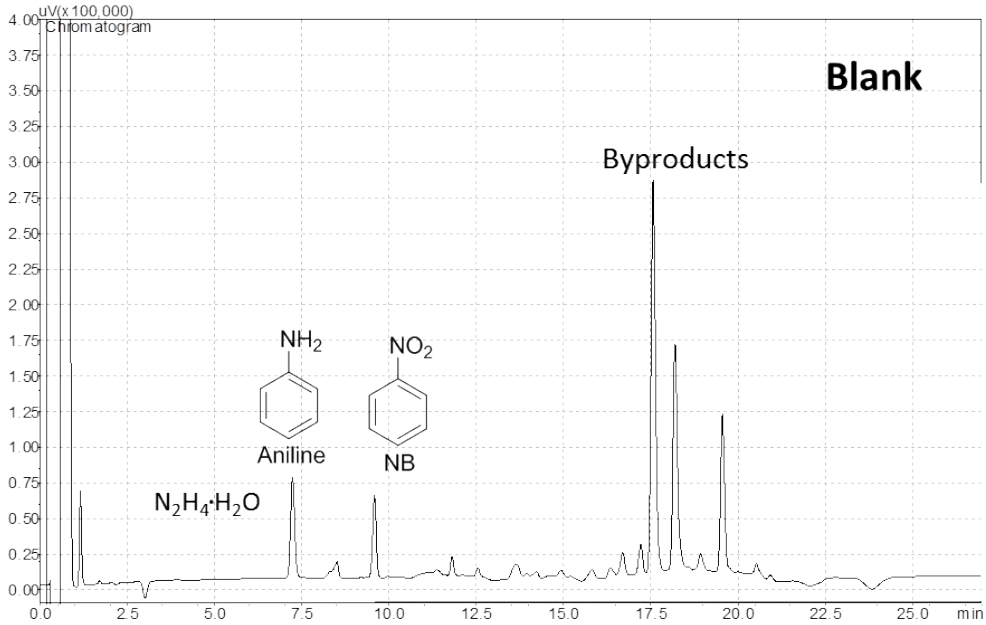

Figure S18. GC chromatogram for reaction mixture treated without catalyst

Reference

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