# -Supporting information-

# Cu and Fe oxide dispersed on SBA-15: A Fenton type catalyst for *N*, *N*-diethyl-p-phenyl diamine degradation

---

**S.Karthikeyan,[a,c] M.P.Pachamuthu,[b] Mark Isaacs,[c] Santosh Kumar,[a] Adam F. Lee[a*], G.Sekaran,[c*]**

[a] *European Bioenergy Research Institute, Aston University, Aston Triangle, Birmingham B4 7ET, United Kingdom*

[b] *Department of Chemistry, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu 638 401 India.*

[c] *Environmental Technology Division, Central Leather Research Institute, Adyar, Chennai 600020, India.*

*** Corresponding Author**

**Dr. G. Sekaran,**

Chief Scientist & Cluster chairman

Environmental Technology Division,

Central Leather Research Institute,

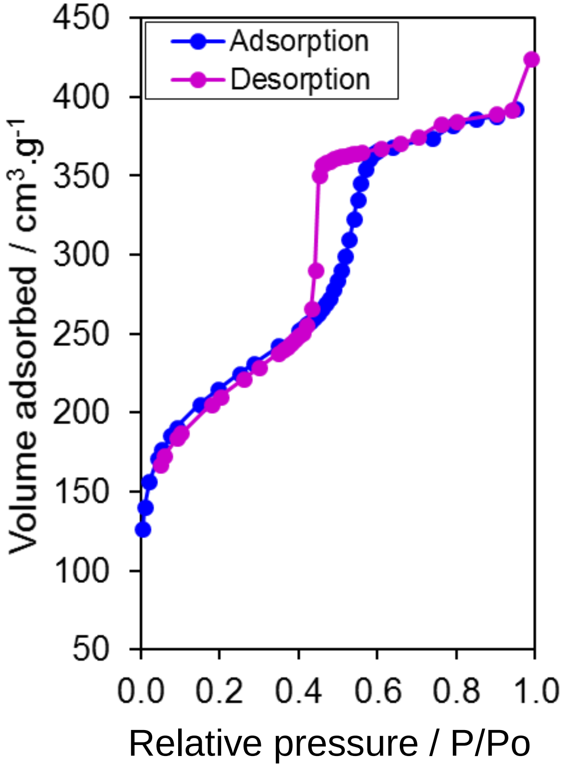
Adyar, Chennai – 600 020,

Tamil Nadu, India

Tel.: +91-44-24911386 (Extn: 7141)

Fax: +91-44-24452941

**Email: ganesansekaran@gmail.com**


Adsorption
Desorption
Volume adsorbed / cm$^3$.g$^{-1}$
450
400
350
300
250
200
150
100
50
0.0
0.2
0.4
0.6
0.8
1.0
Relative pressure / P/Po

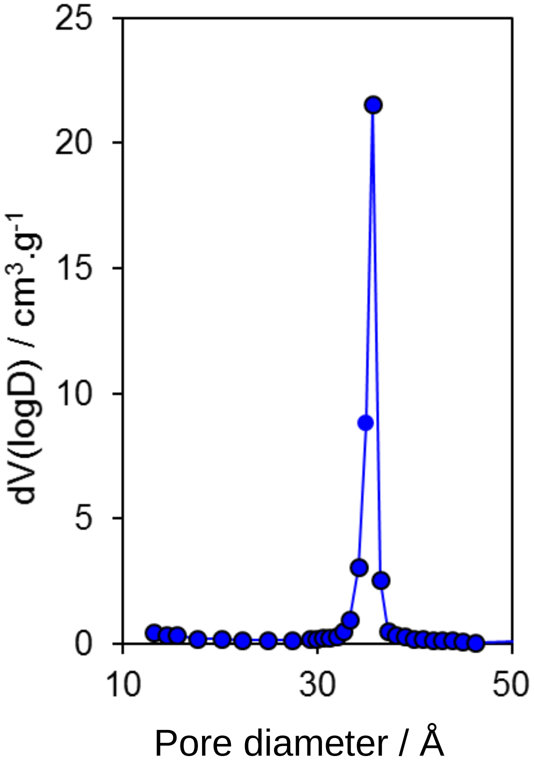

dV(logD) / cm$^3$.g$^{-1}$
25
20
15
10
5
0
10
30
50
Pore diameter / Å

**Fig. S1.** (a) $N_2$ adsorption-desorption isotherms and (b) BJH pore size distributions of SBA-15.

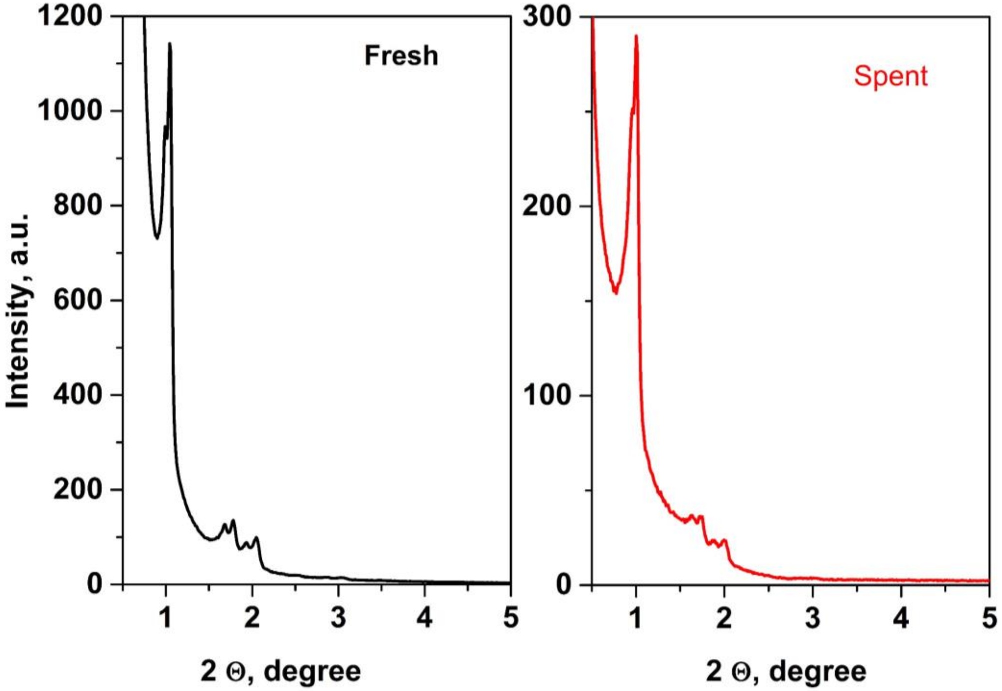


**Fig. S2.** Low angle XRD patterns of as-prepared and spent CuFe/SBA-15 highlighting retention of ordered mesoporosity.

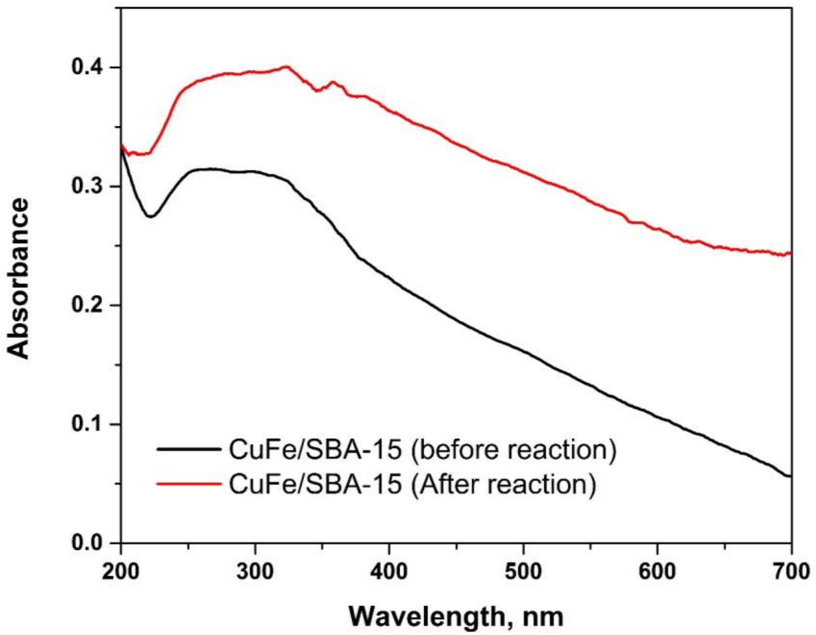


**Fig. S3.** DRUVS spectrum of as-prepared and spent CuFe/SBA-15 catalyst highlighting retention of oxide phases.

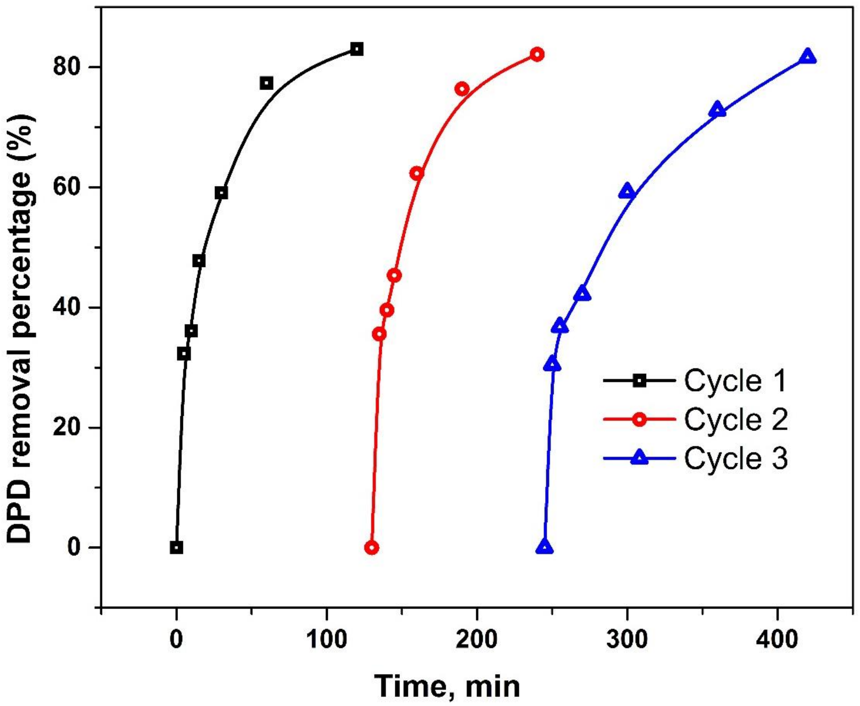


**Fig. S4.** Recycle tests for the oxidativbe degradation of DPD over CuFe/SBA-15. Reaction conditions: 100 mL water, 100 mg DPD, 10 mg catalyst, 25 °C and 8 mM $H_2O_2$. Catalyst was centrifuged, washed repeatedly with water, and placed into a fresh DPD solution.

## HPLC and LC-MS analysis

Some of the degraded products were determined by HPLC (Shimadzu) using a C18 column (Phenomenex Luna 5µ, C18 (2), 100 Å) detector UV 254 nm (acetnitrile + phosphate buffer eluent). Some of the degraded products were determined by HPLC (Shimadzu) using a C18 column (Phenomenex Luna 5µ, C18 (2), 100 Å) detector UV 254 nm (acetonitrile + phosphate buffer eluent). A Micromass QuattroII triple quadrupole ESI LC-MS system was also used to identify the degraded products in positive ionization mode. The DPD solution was introduced to the ESI source through a syringe pump at 5 µL/min. The ESI capillary was set at 3.5 kV and the cone voltage was 40 V, the source temperature

120 °C and the desolvation temperature 300 °C, with spectra collected in 6 s scans. A range of products were observed including *N*$^1$, *N*$^1$-diethybenzene-1,4-diamine, methanol, *N*-ethyl-*N*-(4-iminocyclohexa-2,5-dien-1-ylidene)ethanaminium salt, *N*-ethyl-*N*-(4-iminocyclohexa-2,5-dien-1-ylidene)ethanaminium, 2,2'-azanediyldiacetic acid, 2,2'-azanediyldiethanol, diethylamine, benzoquinone, acetaldehyde, acetic acid, formic acid, oxalic acid, ethanol. Typical HPLC chromatograms are shown in **Figure S1** below.

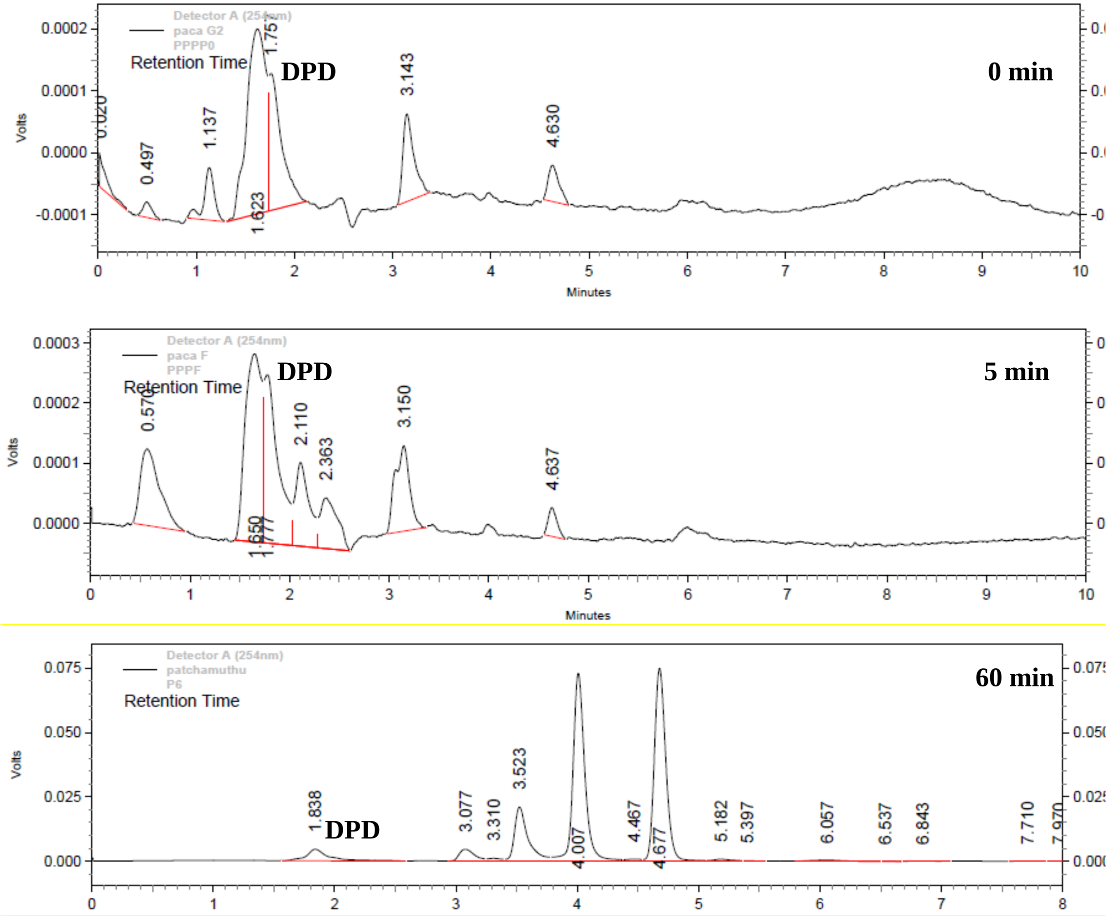


**Fig. S5.** HPLC chromatograms during DPD Fenton oxidative degradation over CuFe/SBA-15 as a function of reaction time.

**Table S1.** Cost analysis for purification of 100 L of DPD contaminated waste water (0.5 g DPD / L)

| | Volume | Purification Cost | | |
|---|---|---|---|---|
| | | GBP | USD | INR |
| DPD | 50 g/100 L | - | - | - |
| CuFe/SBA-15 | 10 g/100 L | 3.88 | 5.49 | 368.9 |
| $H_2O_2$ to initiate Fenton oxidation | 70 mL/100 L | 7.01 | 9.92 | 666.4 |
| Sample agitation | N/A | ~1.00 | 1.42 | 95.10 |
| Total catalyst cost to treat 100 L of DPD waste water | N/A | 11.89 | 16.83 | 1130.4 |