Oxalate capped Iron Nano: From Methylene blue degradation to Bis(indolyl)methane synthesis

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**Fig. S1.** UV-vis spectrum of Fe(ox)-Fe$^0$, before and after the oxidation.

**Fig. S2.** Band gap value of Fe(ox)-Fe$_3$O$_4$. 
Fig. S3. Band gap value of Fe$_3$O$_4$. 
Fig. S4. Synthetic procedure of Fe(ox)-Fe⁰.
Characterization of Oxidized product (Reddish-Brown Material)

Fig. S5. TEM, particle distribution, and SAED pattern of Fe₃O₄.
Fig. S6. TEM, particle distribution, and SAED pattern of Fe(ox)-Fe$^0$. 
Table S1 condensation reaction between aldehyde and indoles in water

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Involvement of Fe(ox)-Fe₃O₄ as a catalyst in the condensation reaction between aldehydes and indoles:

There are several different possible modes of coordination of carbonyl group to metal catalysts. Mainly four types of coordination modes of aldehyde have been proposed (scheme 1).¹

Scheme 1. Possible coordination mode of aldehyde with metal catalyst

It is expected that after binding of C=O to metal catalyst, there must be a shift in both the C=O and C-H stretching band of aldehyde as compared to free aldehyde. The material was prepared for the study by grinding the 1:1 mixture of aldehyde and catalyst in a motor pestle for 0.5 h. The two material; Fe₃O₄ and Fe(ox)-Fe₃O₄ was chosen for the study. The FTIR spectra of free 4-bromo benzaldehyde (2a) shows two peaks at 2763 and 2855 cm⁻¹ due to C-H stretching vibration and another two peaks at 1693 and 1577 cm⁻¹ due the C=O stretching vibration of 2a. In the mixture of 2a and Fe(ox)-Fe₃O₄, the C-H stretching vibration at 2763 cm⁻¹ of 2a shifted to lower wavenumber, which indicates the binding of 2a with Fe(ox)-Fe₃O₄ catalyst (Fig. S7). On the other hand the C=O stretching vibration at 1693 for free 2a also shifted to lower wavenumber in the mixture of 2a and Fe(ox)-Fe₃O₄ sample (Fig. S8), which also suggested the interaction of
2a with Fe(ox)-Fe$_3$O$_4$. In case of Fe$_3$O$_4$ material, less shift of C=O and C-H stretching vibration was observed as compared to Fe(ox)-Fe$_3$O$_4$.

**Fig. S7.** FTIR spectra of 4-bromo benzaldehyde (C-H stretching band) on Fe$_3$O$_4$ and Fe(ox)-Fe$_3$O$_4$. 
Fig. S8. FTIR spectra of 4-bromo benzaldehyde (C-O stretching band) on Fe$_3$O$_4$ and Fe(ox)-Fe$_3$O$_4$. 
Fig. S9. FTIR spectra of 4-bromo benzaldehyde on Fe(ox)-Fe$_3$O$_4$.

Fig. S10. FTIR spectra of 4-bromo benzaldehyde on Fe$_3$O$_4$. 
Fig S11. FTIR spectra of Fe\textsubscript{3}O\textsubscript{4}.

Fig S12. FTIR spectra of Fe(ox)-Fe\textsubscript{3}O\textsubscript{4}.
Fig S13. Absorbance versus wavelength plot of Fe(ox)-Fe₃O₄ promoted reaction of methylene blue in dark.

Fig S14. Degradation (%) versus time plot of Fe(ox)-Fe₃O₄ promoted reaction of methylene blue in dark.
Fig S15. 1H and 13C NMR spectrum of compound 1a in acetone-d$_6$. 
Fig S16. $^1$H and $^{13}$C NMR spectrum of compound 1b in acetone-d$_6$. 
Fig S17. $^1$H and $^{13}$C NMR spectrum of compound 1c in DMSO-d$_6$
Fig S18. $^1$H and $^{13}$C NMR spectrum of compound 1d in Acetone-$d_6$. 
Fig S19. $^1$H and $^{13}$C NMR spectrum of compound 1e in Acetone-d$_6$
Fig S20. $^1$H and $^{13}$C NMR spectrum of compound 1f in Acetone-d$_6$
Fig S21. $^1$H and $^{13}$C NMR spectrum of compound 1g in Acetone-d$_6$. 
Fig S22. $^1$H and $^{13}$C NMR spectrum of compound 1h in Acetone-d$_6$. 
Fig S23. $^1$H and $^{13}$C NMR spectrum of compound 1i in Acetone-\textit{d}_6.
Fig S24. $^1$H and $^{13}$C NMR spectrum of compound 1j in Acetone-d$_6$.

References: