Supporting Information

Sustainable one-step strategy towards low temperature curable superparamagnetic composite based on smartly designed Iron nanoparticles and Cardanol Benzoxazine

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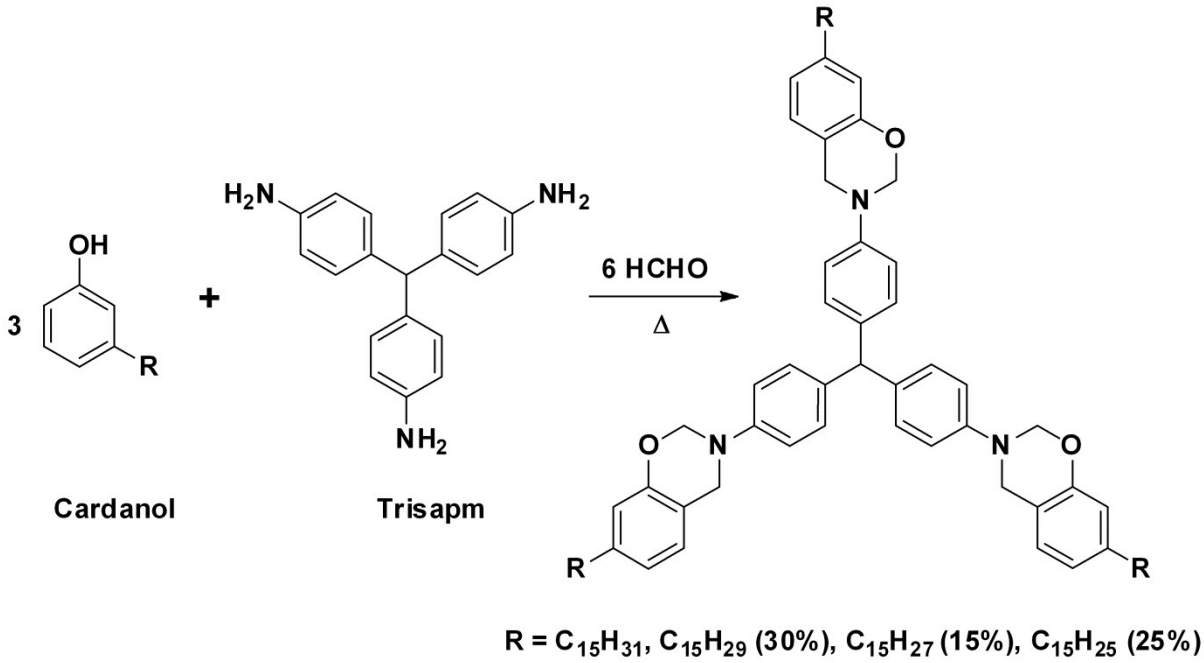
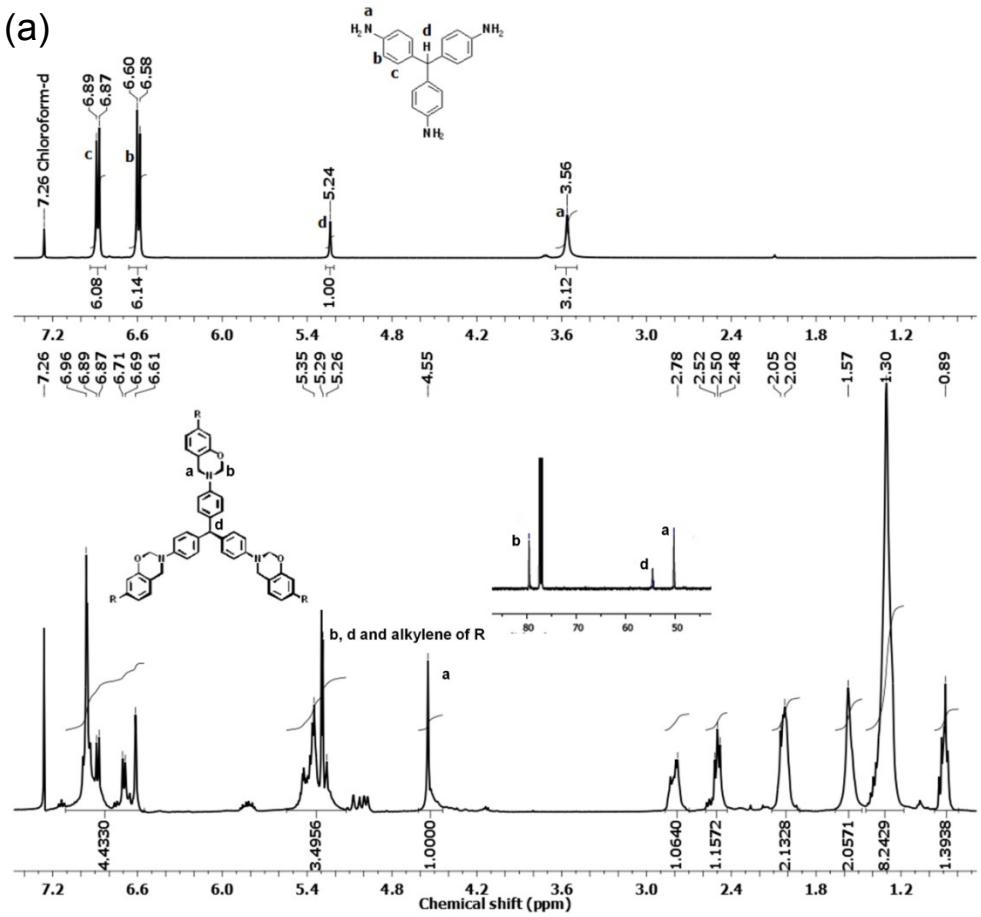


Figure S1: Synthesis of C-trisapm



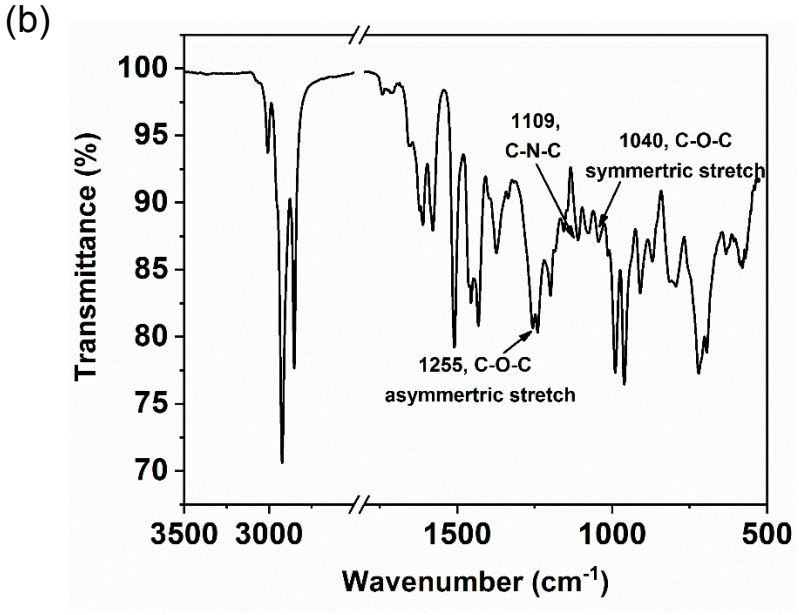


Figure S2: ^{1}H-NMR spectra of trisapm (a) and C-trisapm (inset shows the ^{13}C-spectrum of C-trisapm) in $CDCl_3$; (b) FTIR spectrum of C-trisapm

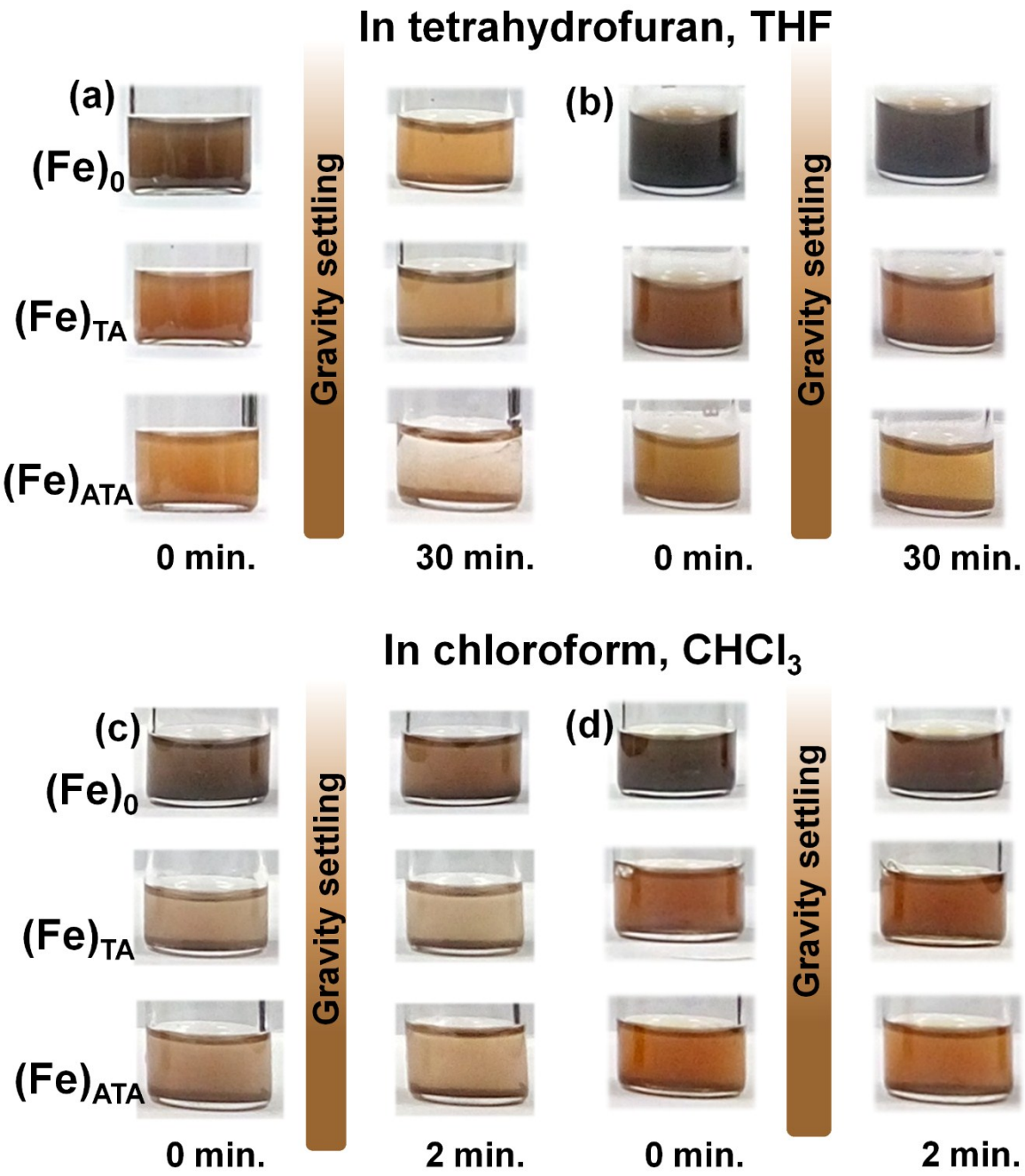


Figure S3: Digital images of suspension of iron nanoparticles (a, c) and their blends in cardanol benzoxazine (b, d) in THF and chloroform (2.5 mg/mL loading of NPs) at room temperature.

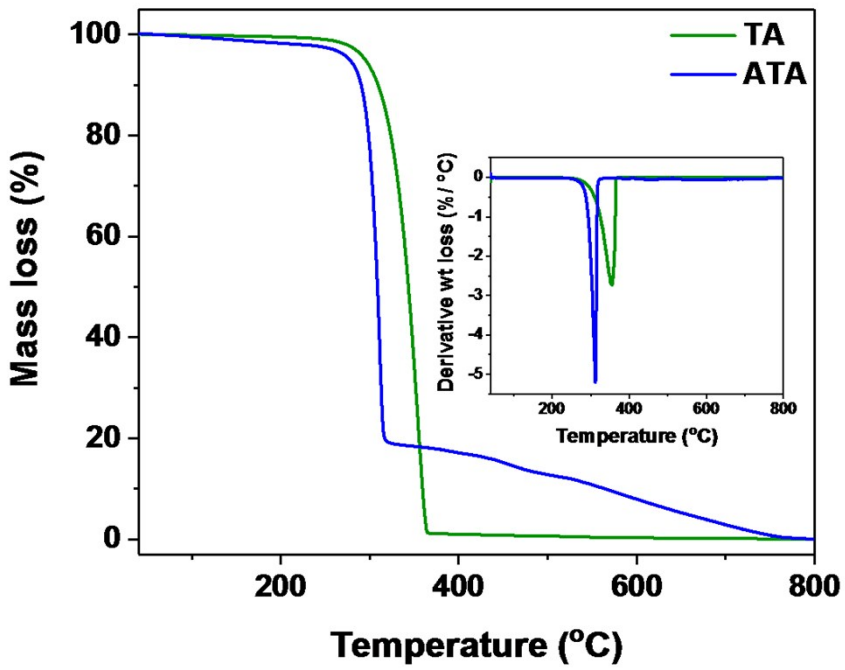


Figure S4: TGA (a) and DTG (b) traces of TA and ATA at a heating rate of 10 °C/ min. under nitrogen atmosphere.

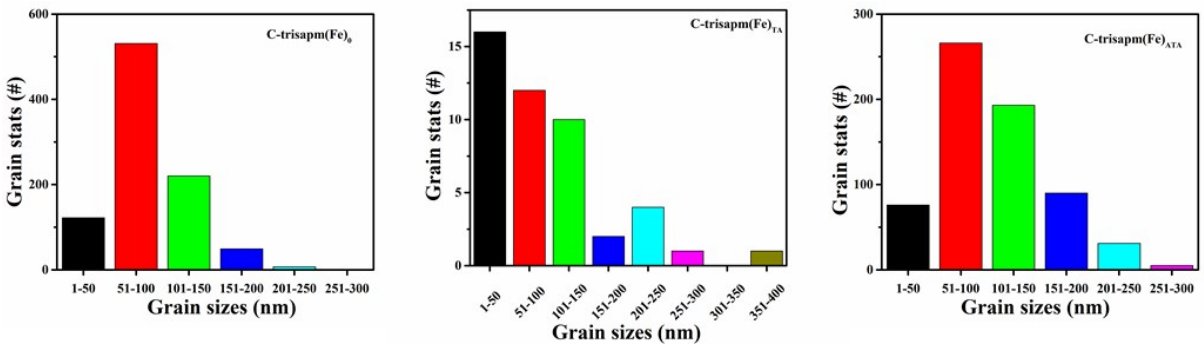


Figure S5: Histograms for grain size distribution in polymer-nanoparticles composites evaluated from the AFM images of 2μm × 2μm scan area.

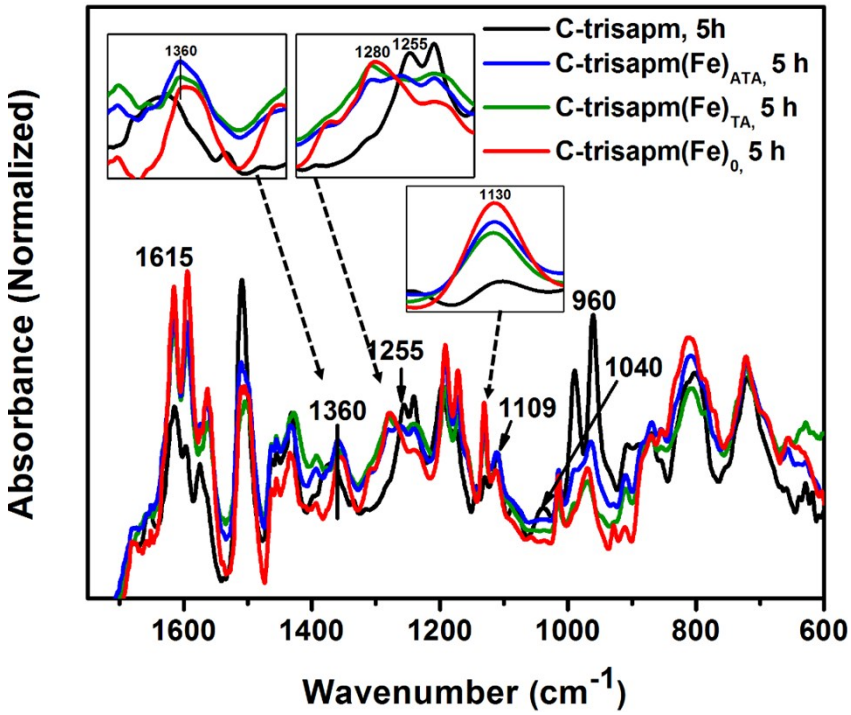


Figure S6: Normalized transmission IR absorption spectra of C-trisapm blends after curing at 150 ^{o}C for 5h.

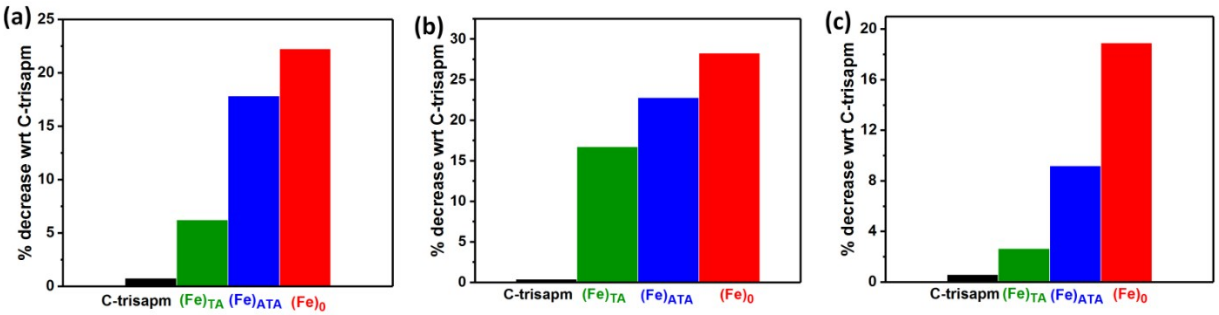


Figure S7: Relative change in intensity of normalized FTIR spectra in the monomer and its blend with iron NPs (150 ^{o}C for 2 h) at (a) 1255 cm^{-1}, (b) 1040 cm^{-1}, and (c) 1109 cm^{-1} due to C-O-C_{asym}, C-O-C_{sym} and C-N-C stretching frequencies respectively.

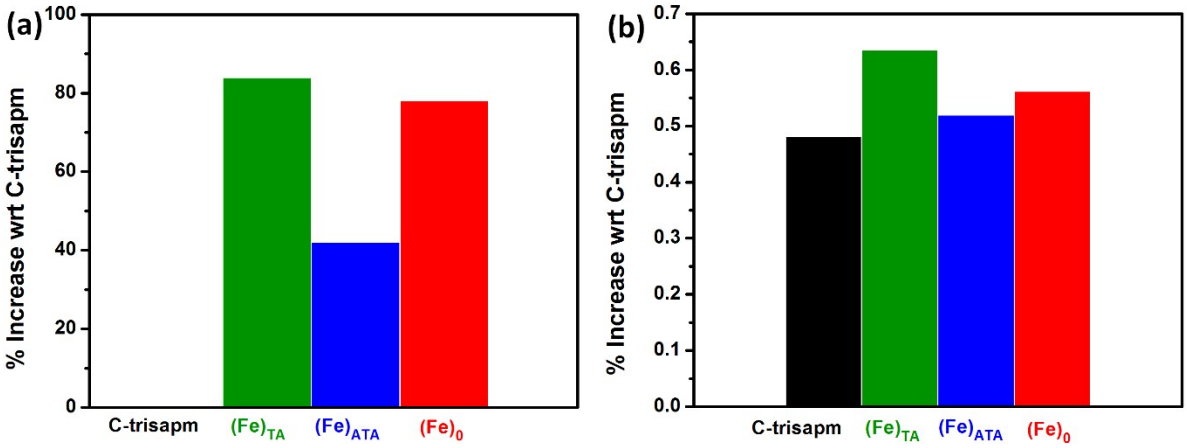


Figure S8: Relative change in intensity of normalized FTIR spectra in the monomer and its blend with iron NPs (150 ^{o}C for 2 h) at (a) 1615 cm^{-1}, and (b) 1360 cm^{-1}. There is no peak at 1360 cm^{-1} in case of C-trisapm, we have taken the absorbance value at 1360 cm^{-1} in peak at 1370 cm^{-1} for comparison purposes.

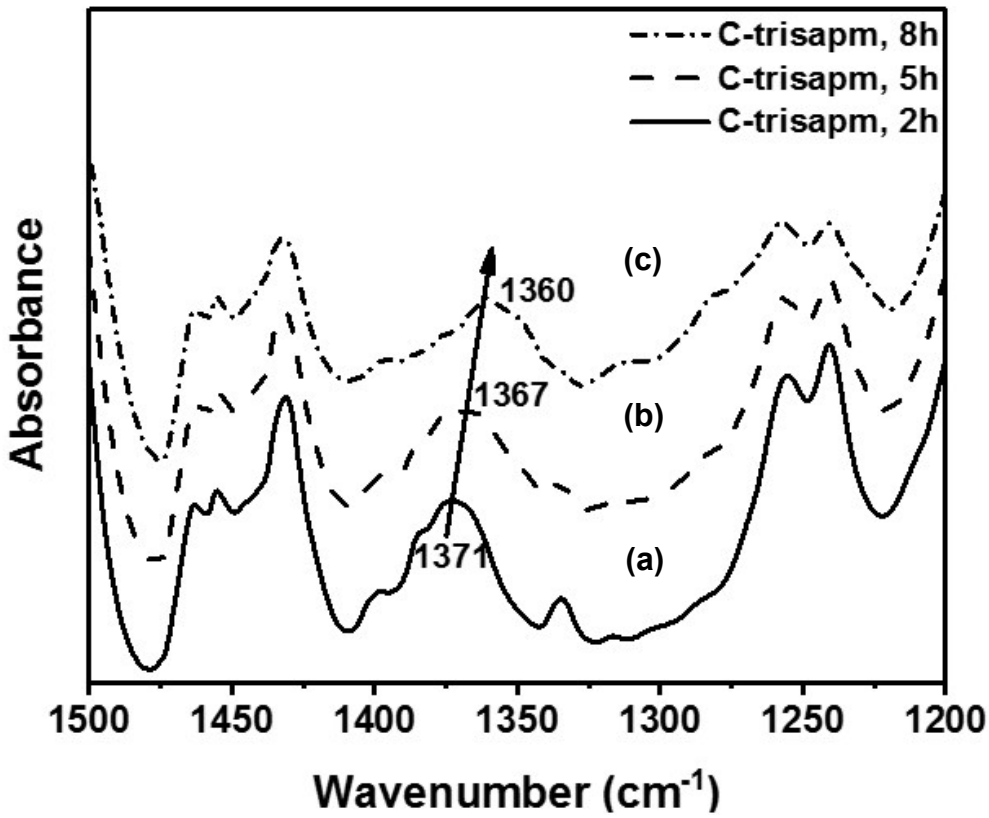
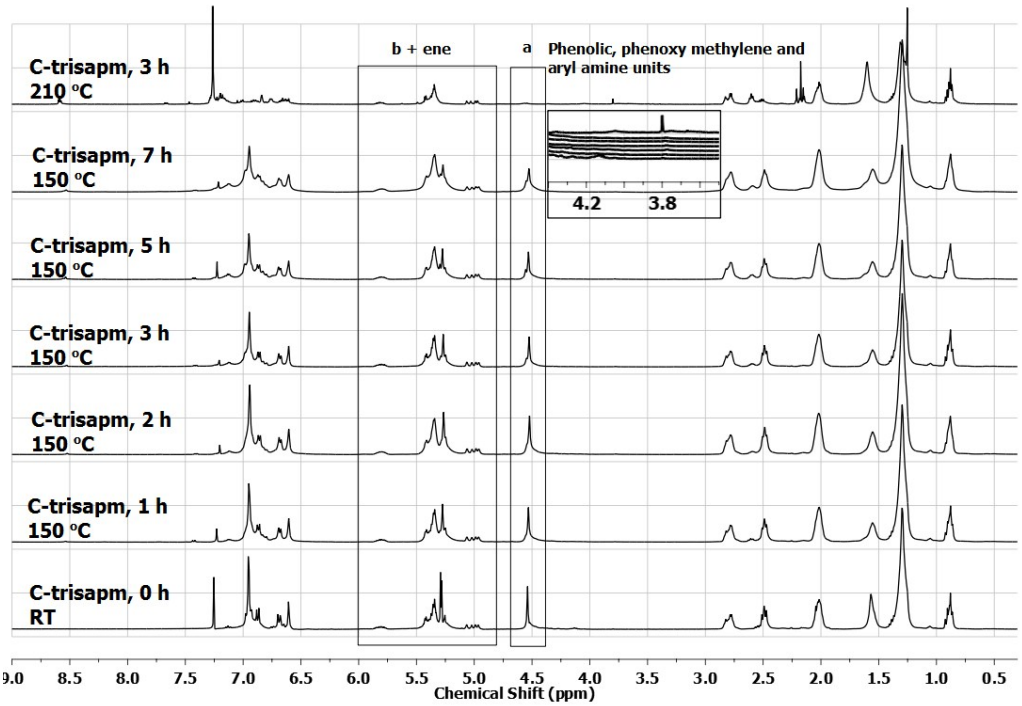
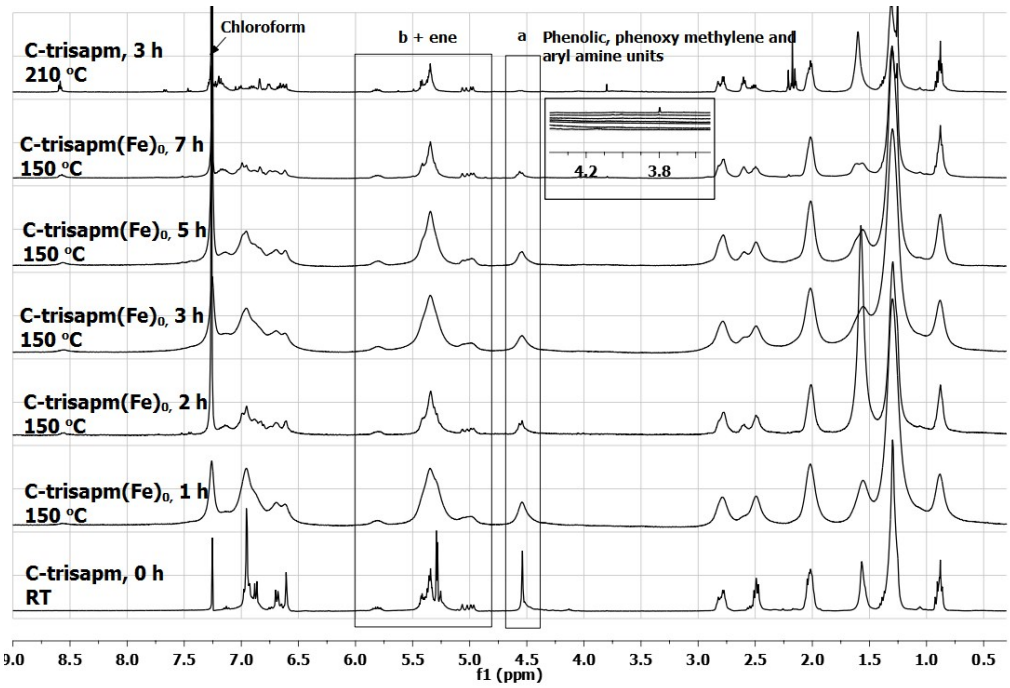


Figure S9: FTIR spectra of C-trisapm showing development of 1360 cm^{-1} stretch after curing at 150 ^{o}C for 2 h (a), 4h (b) and 8 h (c).

(a)


b + ene
a
Phenolic, phenoxy methylene and aryl amine units
C-trisapm, 3 h 210 °C
C-trisapm, 7 h 150 °C
C-trisapm, 5 h 150 °C
C-trisapm, 3 h 150 °C
C-trisapm, 2 h 150 °C
C-trisapm, 1 h 150 °C
C-trisapm, 0 h RT
4.2
3.8
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
Chemical Shift (ppm)

(b)


Chloroform
b + ene
a
Phenolic, phenoxy methylene and aryl amine units
C-trisapm, 3 h 210 °C
C-trisapm(Fe)0, 7 h 150 °C
C-trisapm(Fe)0, 5 h 150 °C
C-trisapm(Fe)0, 3 h 150 °C
C-trisapm(Fe)0, 2 h 150 °C
C-trisapm(Fe)0, 1 h 150 °C
C-trisapm, 0 h RT
4.2
3.8
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

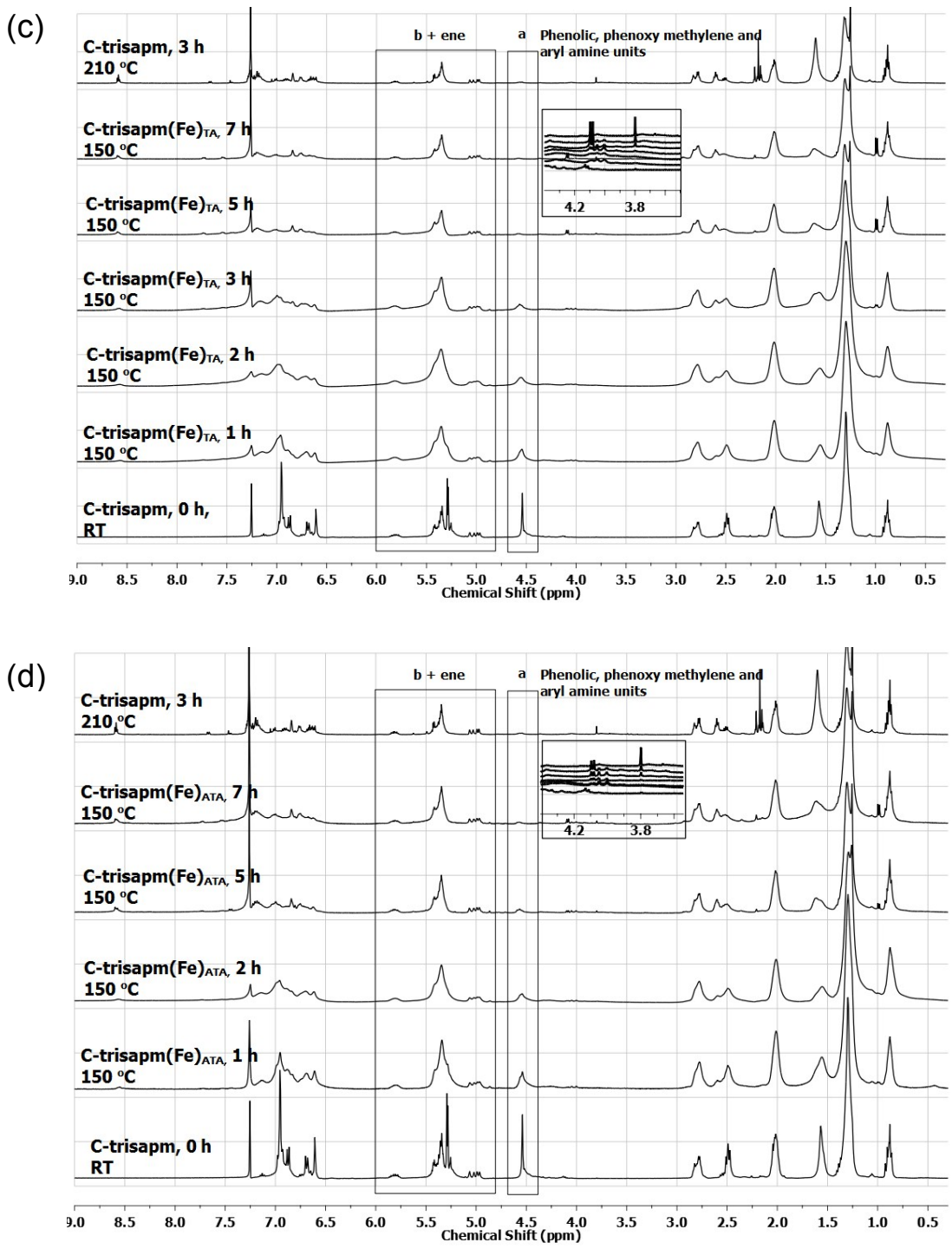


Figure S10: Stacked time dependent normalized ^{1}H-NMR spectra of a) C-trisapm, b) C-trisapm(Fe)$_0$, c) C-trisapm(Fe)$_{TA}$, d) C-trisapm(Fe)$_{ATA}$ obtained from the reaction mixture at different time intervals at 150 °C. ^{1}H-NMR of C-trisapm at a higher temperature 210 °C for 3 h is shown to notice the changes in relative manner. Inset in figures showed a zoom in region from 3.5-4.4 ppm.

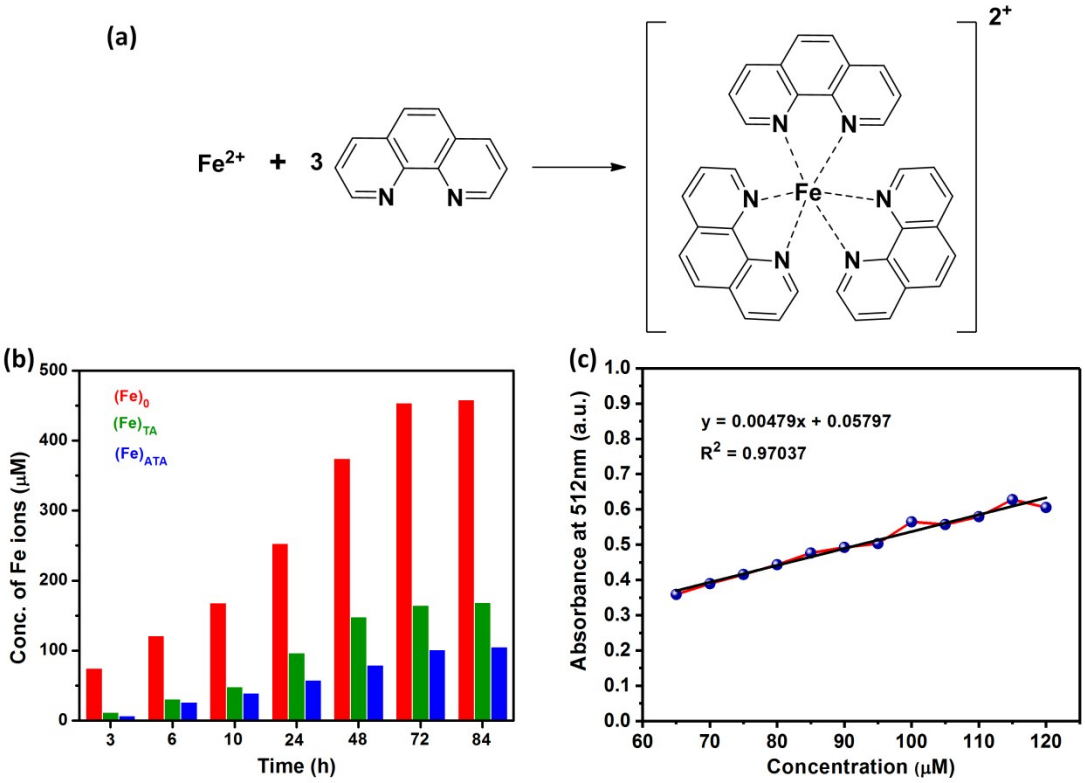


Figure S11: Iron ion concentration in NPs: (a) complexation of Fe^{2+} ion with *o*-phenanthroline, (b) concentration of iron ions available with time, and (c) standard curve of $FeCl_3$ with *o*- phenanthroline.

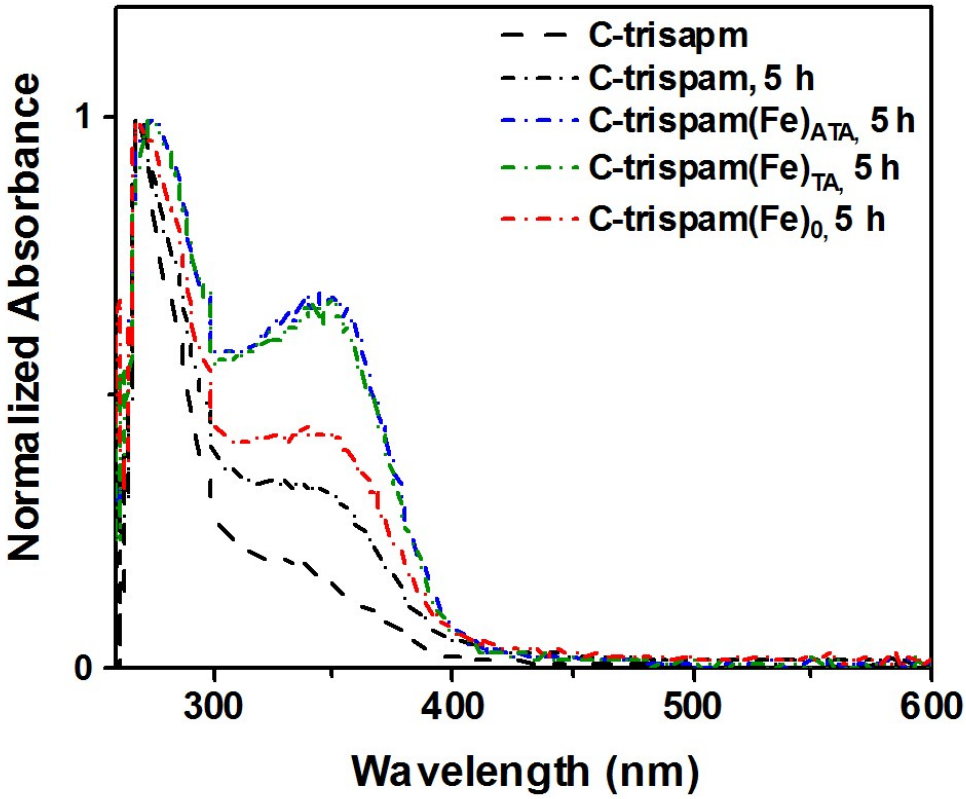


Figure S12: Normalized UV-vis. spectra of blends C-trisapm obtained after heating at 150 ^{o}C for 5 h, recorded in DMSO as solvent

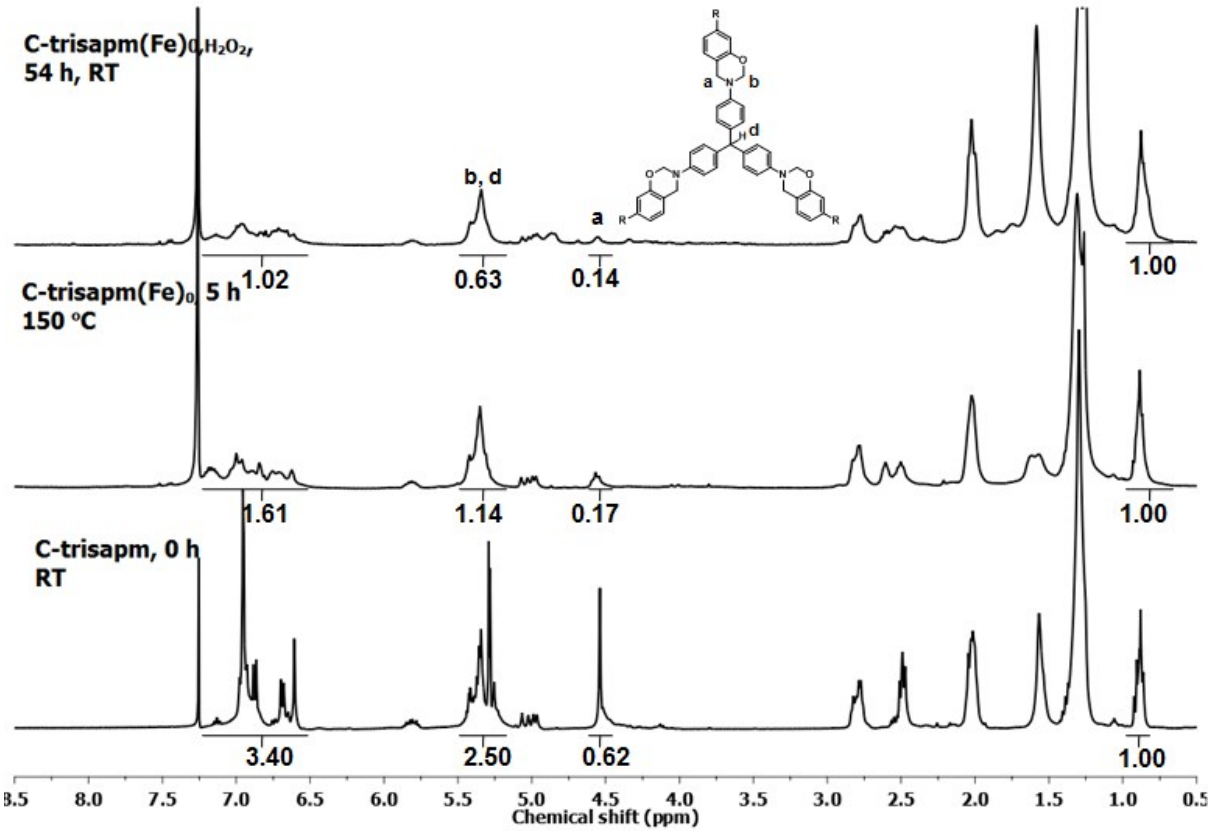


Figure S13: Stacked normalized ^{1}H-NMR spectra of C-trisapm monomer and its polymerization reaction mediated by the presence of $(Fe)_0$ NPs using hydrogen peroxide vs. air.

Table S1: Molecular weight of soluble fraction in blends present after curing at 150 °C for 2h.

C-trisapm(Fe)$_0$		**C-trisapm(Fe)$_{TA}$**		**C-trisapm(Fe)$_{ATA}$**	
***M*w**	**PDI**	***M*w**	**PDI**	***M*w**	**PDI**
2174	2.7	2747	3.0	2146	3.2

Table S2: Magnetic properties of thermally cured C-trisapm blends.

Sample	M_S (emu/g)	M_R (emu/g)
(Fe)$_0$	59.05	10
(Fe)$_{TA}$	34.62	9.4
(Fe)$_{ATA}$	16.06	6.3
C-trisapm(Fe)$_0$	1.66	0.03
C-trisapm(Fe)$_{TA}$	1.81	0.56
C-trisapm(Fe)$_{ATA}$	1.23	0.15