Supporting Information

A simple maskless process for fabrication of vertically aligned high density hematite and graphene/magnetite nanowires

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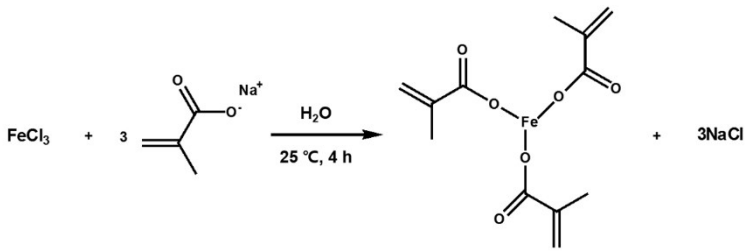

Figure S1. The synthetic scheme of iron(Ⅲ) methacrylate.

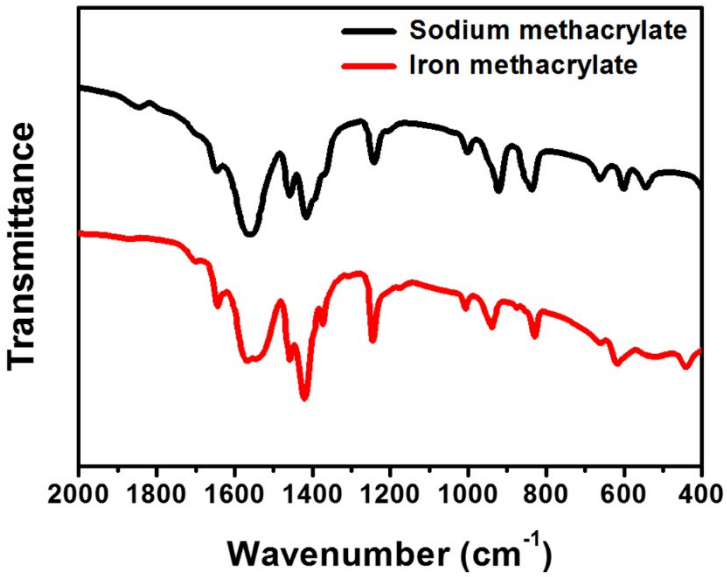

Figure S2. FTIR spectrum of sodium methacrylate and iron methacrylate.

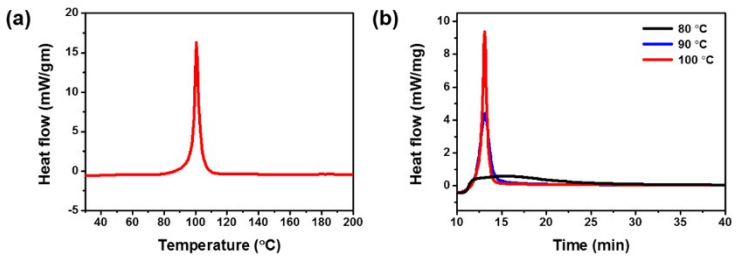

Figure S3. The heat released during (a) nonisothermal and (b) isothermal crosslinking reaction of the formulated resin in DSC data.

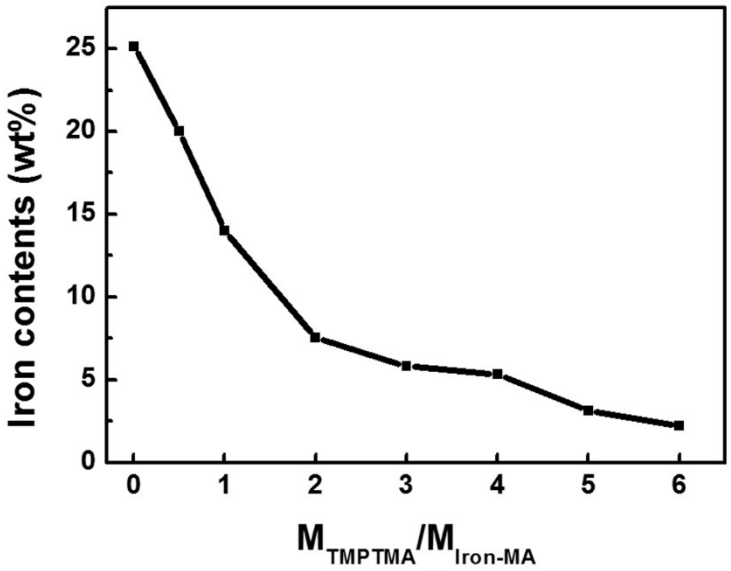

Figure S4. Iron content versus the mass ratio of TMPTMA/iron methacrylate at a fixed mass ratio of MMA/iron methacrylate.

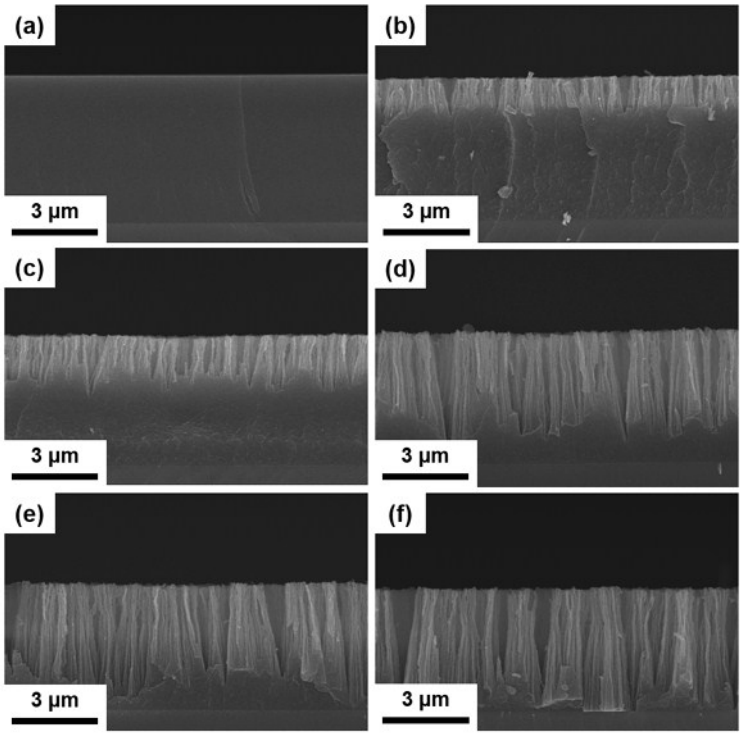

Figure S5. Cross-sectional SEM images of the oxygen plasma exposed film ($M_{Iron\text{-}MA}$:

M_{TMPTMA} : M_{MMA} = 1:4:4) with different etching times. (a) 0 min, (b) 5 min, (c) 8 min, (d) 10 min, (e) 15 min and (f) 20 min.

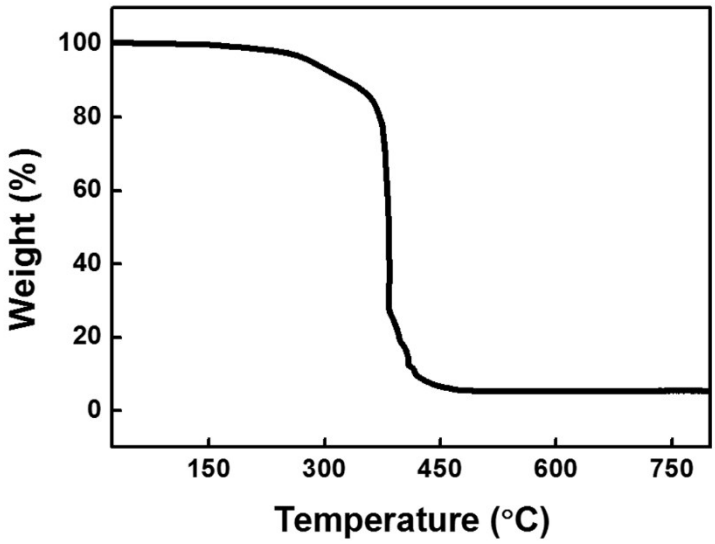

Figure S6. Thermal gravimetric analysis (TGA) of the cured composite resin. The organic portion decomposed in a temperature range of 300-430 ℃, leaving behind about 5.4 % of the original mass.

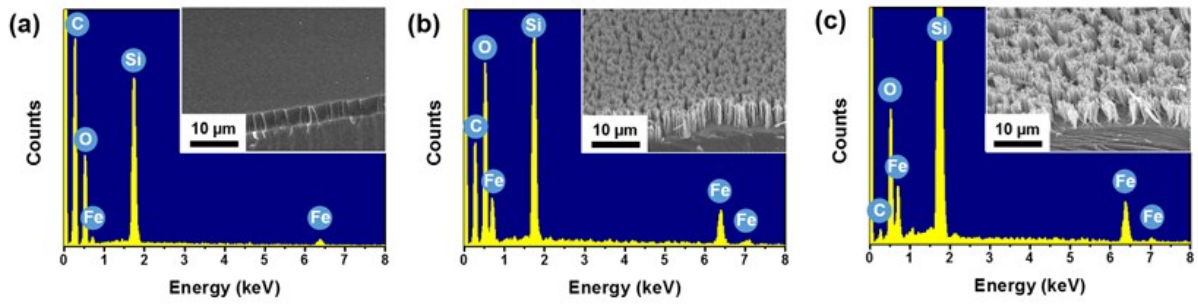

Figure S7. EDS data obtained from (a) iron-containing polymer film after curing, (b) iron oxide/organic nanowires after oxygen plasma treatment and (c) hematite nanowires after calcination at 500 ℃ for 1 hr. (inset images : SEM images of each measured samples)

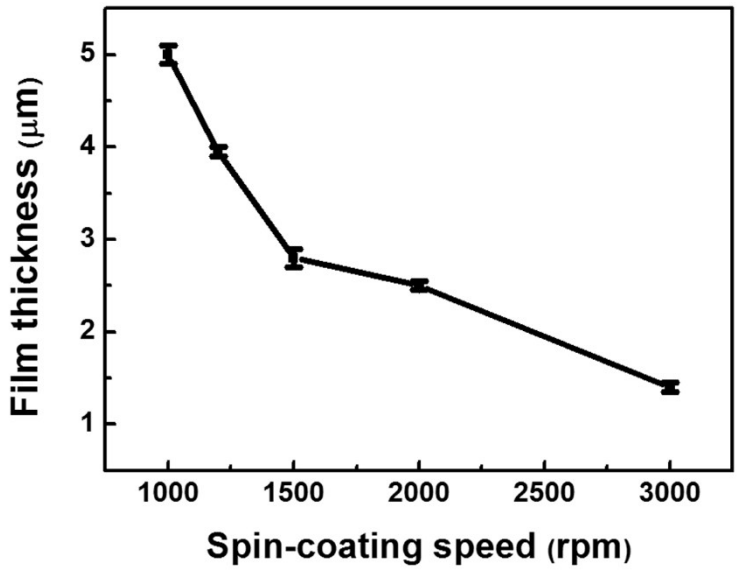

Figure S8. Control of film thickness by adjustment of spin coating speed for the 1:4:4 ($M_{Iron\ MA}$: M_{TMPTMA} : M_{MMA}) composite resin.

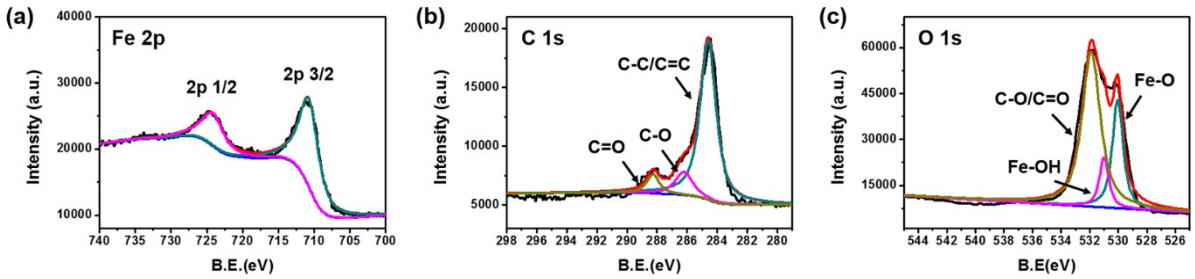

Figure S9. XPS spectra of the graphene/magnetite nanowires after carbonization: (a) Fe 2p, (b) C 1s and (c) O 1s.

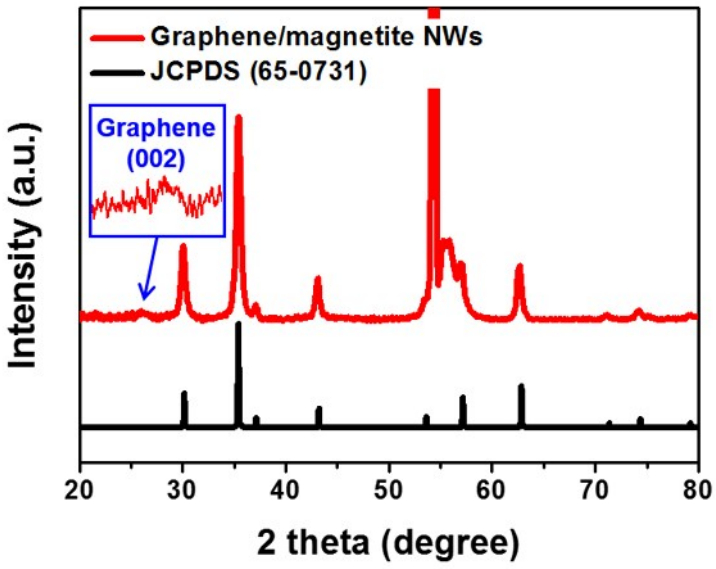

Figure S10. XRD data of the graphene/magnetite nanowires on Si substrate.

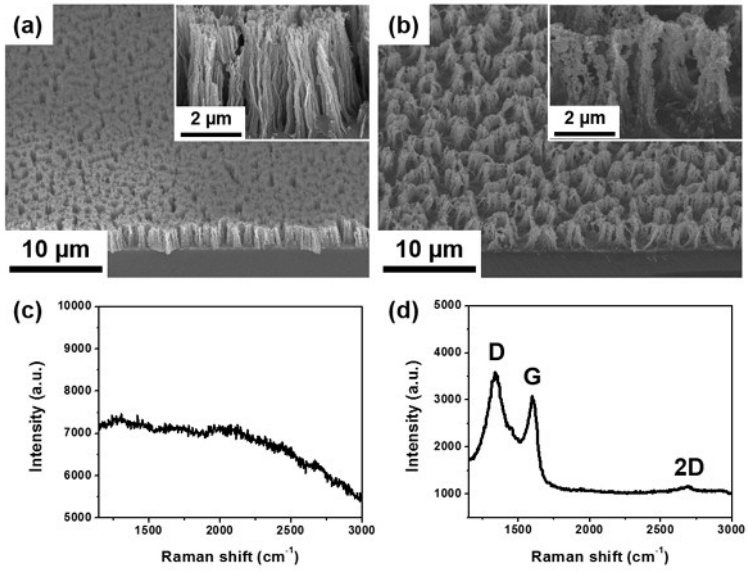

Figure S11. Cross-sectional SEM images and of nanowire arrays (a) before and (b) after carbonization at 700 ℃ for 30 min under H_2/Ar 50/50 sccm. Raman spectra of each obtained nanowires (c) before and (d) after carbonization, respectively.

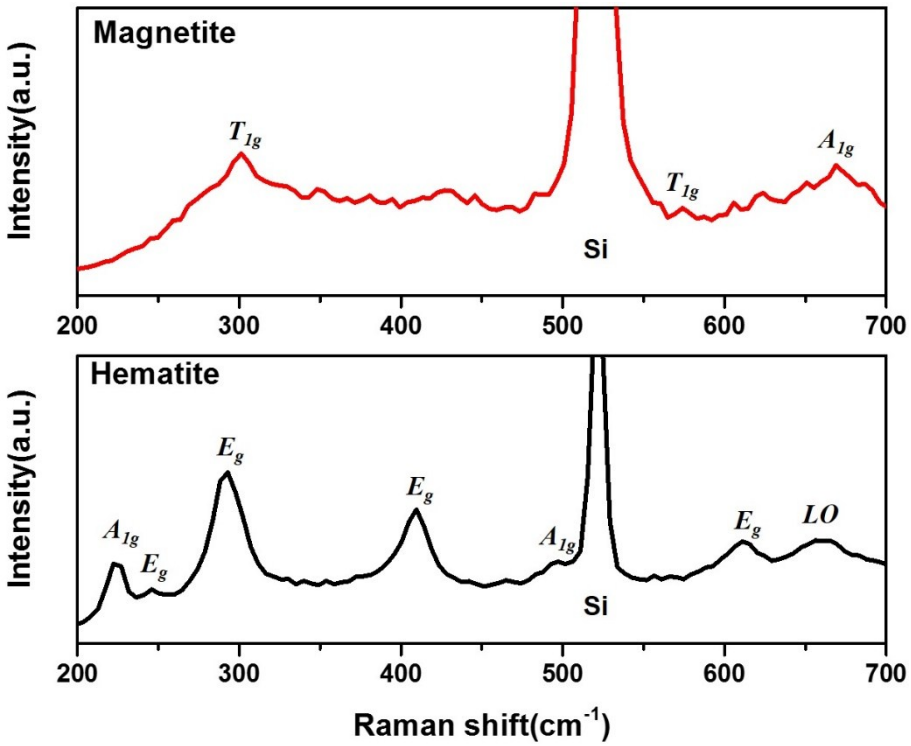

Figure S12. Raman spectra of hematite nanowires calcined at 500 °C in air and graphene/magnetite nanowires calcined at 700 °C in H_2/Ar.

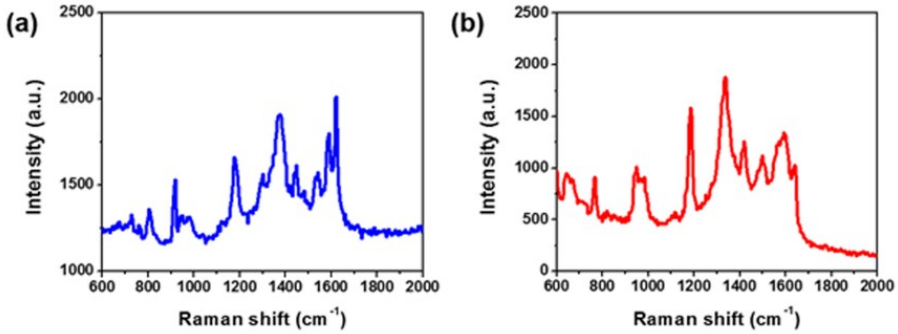

Figure S13. Raman spectra of (a) Crystal violet and (b) fluorescein dye on graphene/magnetite nanowires.

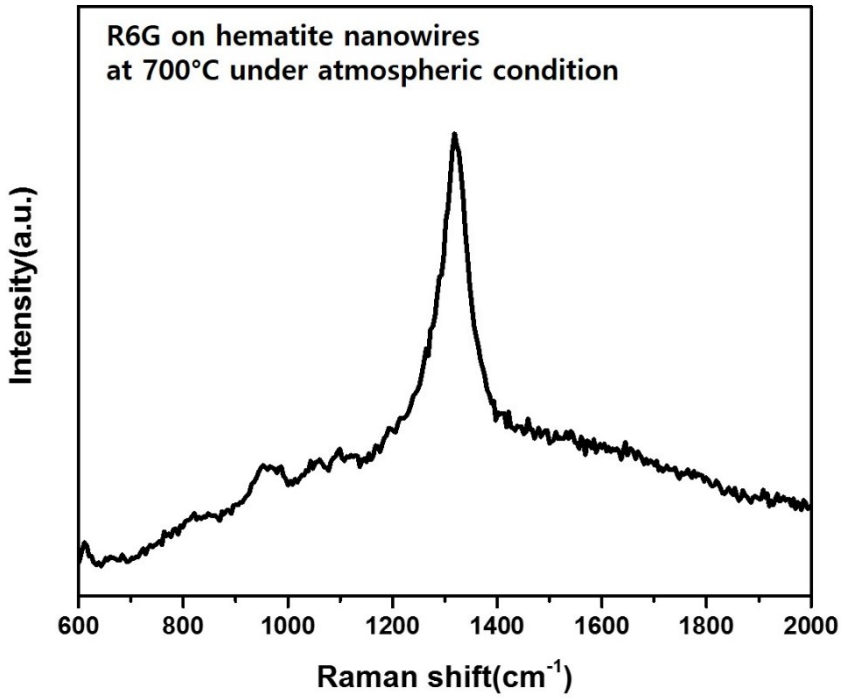

Figure S14. Raman spectra of R6G on hematite nanowires calcined at 700 °C in air

Table S1. Comparison study of multilayered-graphene/magnetite nanowires in this work and previously reported GERS substrates.

GERS substrate	Probe molecules	Enhancement factor	Reference substrate	Reference
Graphene monolayer	Phthalocyanine, Rhodamine 6G, etc	2-17	SiO_2/Si substrate	1
Graphene nanomesh	Rhodamine B	2	Single layer graphene	2
Graphene quantum dots	Rhodamine 6G	40-74	Si substrate	3
Graphene monolayer	Copper phthalocyanine	47.3	SiO_2/Si substrate	4
Reduced graphene monolayer	Rhodamine 6G	3-13	SiO_2/Si substrate	5
Reduced graphene oxide nanosheets	Rhodamine B	~ 10^3	SiO_2/Si substrate	6
UV/Ozone-Oxidized Graphene	Rhodamine B	2.6×10^4	SiO_2/Si substrate	7
	Rhodamine 6G	1.6×10^4		
Present work	Rhodamine 6G	7.0×10^4	Si substrate	In this work

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