# Supporting Information

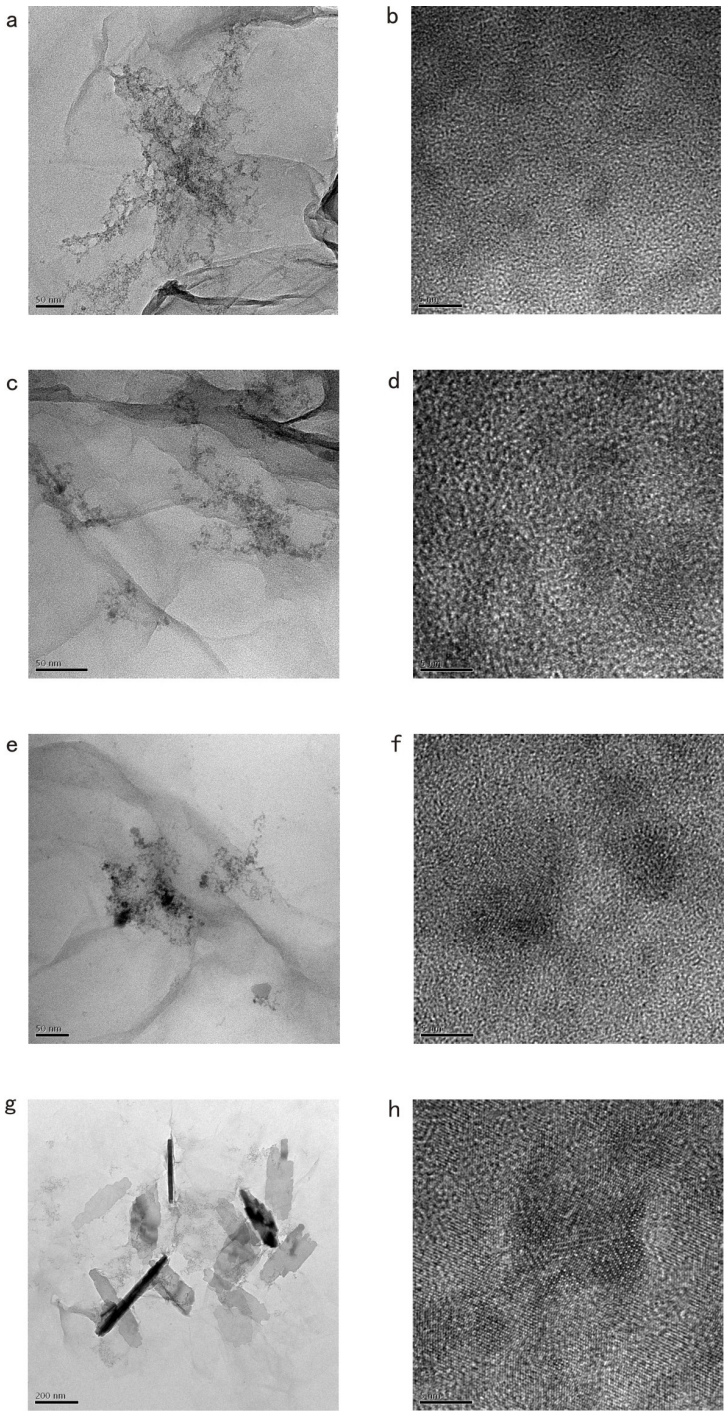



Figure S1. TEM and HRTEM imaging of ultrathin single crystal lepidocrocite nanosheets. a, TEM image of Fe-G 5%. b, HRTEM image of Fe-G 5%. c, TEM image of Fe-G 10%. d, HRTEM image of Fe-G 10%. e, TEM image of Fe-G 15%. f, HRTEM image of Fe-G 5%. g, TEM image of Fe-G 20%. h, HRTEM image of Fe-G 20%.

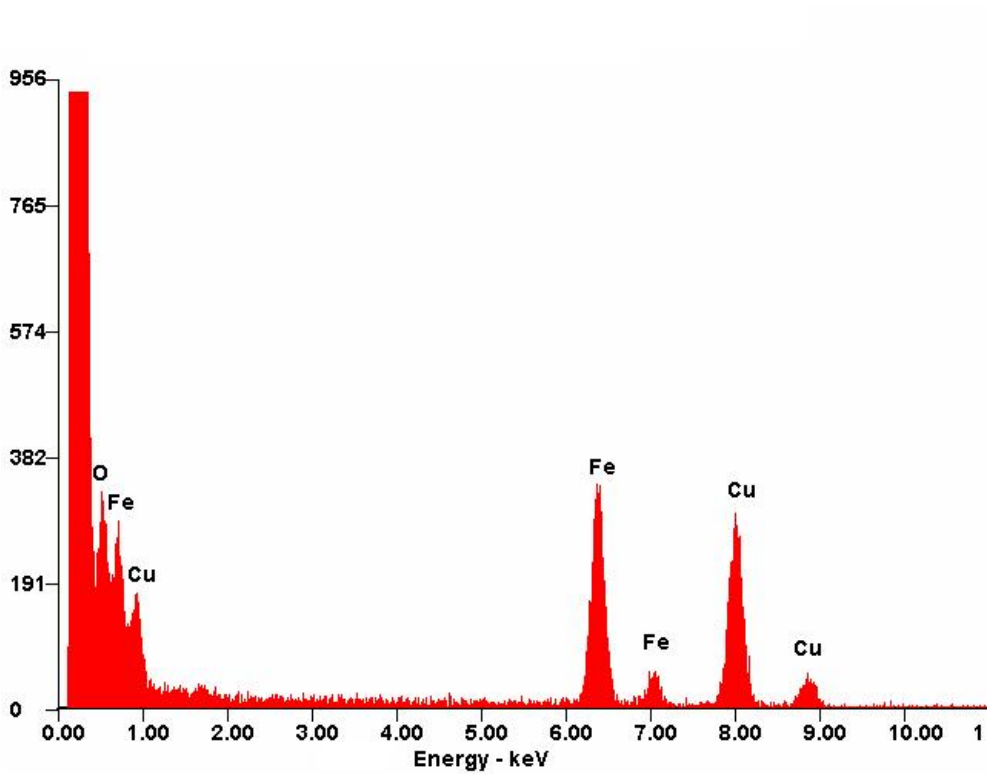
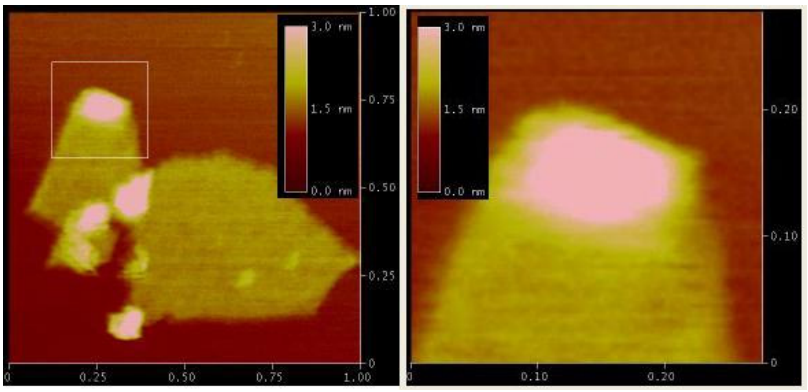
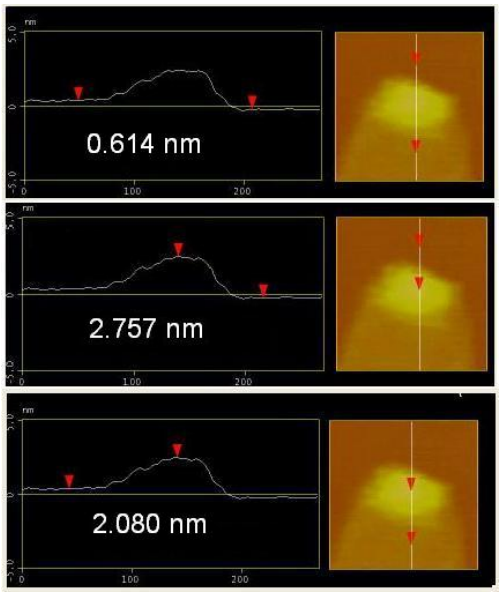



Figure S2. EDS spectrum of ultrathin single crystal lepidocrocite nanosheets.




(a)




(b)

Figure S3. a) AFM image of nanosheets; b) Height analysis in AFM. Height for graphene + Fe nanosheets is 2.8 nm, graphene alone is 0.6 nm, thus the Fe nanosheet is 2.1 nm.

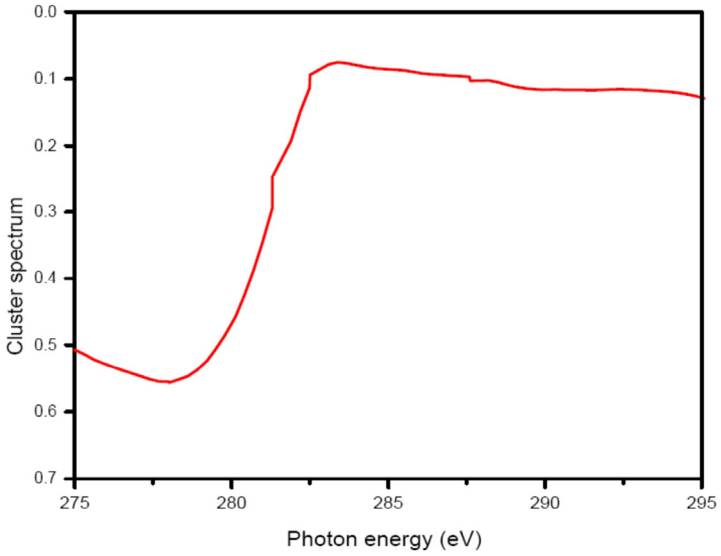



Figure S4. NEXAFS spectrum of reduced graphene oxide in Fe-G 20% nanocomplex.

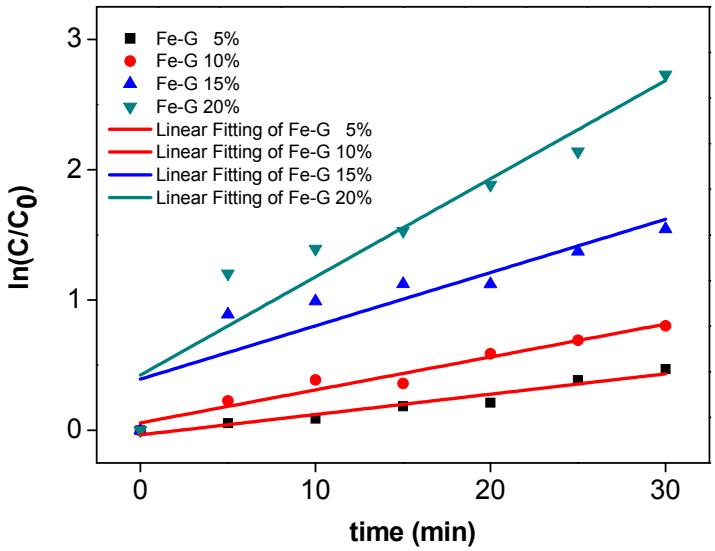



Figure S5. Data fitting with the first-rate reaction kinetics for phenol degradation with Fe-G nanostructures of different Fe contents (shown in Fig. 5e).

The equation for the first-order reaction kinetics is

$C/C_0 = a + b \times e^{-kt}$ (1)

where "C" and "$C_0$" are the concentration and original concentration of phenol, "*t*" is the reaction time and "*k*" stands for the first-order reaction rate, "a" and "b" are the fitting constants.

This equation can be transformed to

$t = a + k \times \ln(C/C_0)$ (2)

By using the equation (2), the phenol degradation data can be linearly fitted for the first 30 min ($R^2$ is Correlation coefficient).

The following table is the parameters for fitting and the *k* values.

| | *a* | *k*(min$^{-1}$) | $R^2$ |
|---|---|---|---|
| Fe-G 5% | -0.035 | 0.016 | 0.940 |
| Fe-G 10% | 0.057 | 0.025 | 0.954 |
| Fe-G 15% | 0.392 | 0.041 | 0.752 |
| Fe-G 20% | 0.423 | 0.075 | 0.885 |

The *k* values are also reported in Table 1.

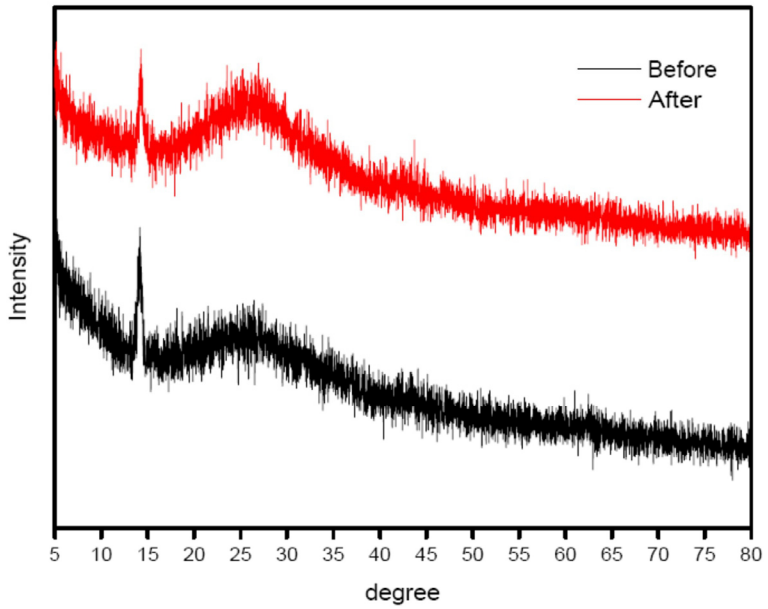



Figure S6. XRD patterns of Fe-G 20% before and after phenol treatment.

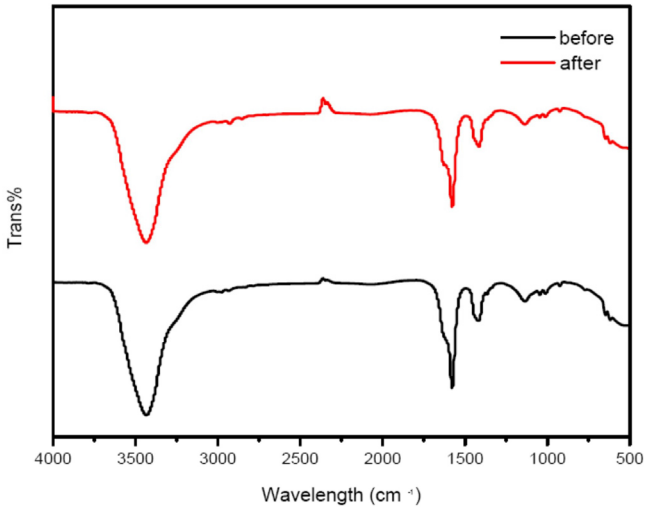



Figure S7. FTIR spectra of Fe-G 20% before and after phenol treatment.

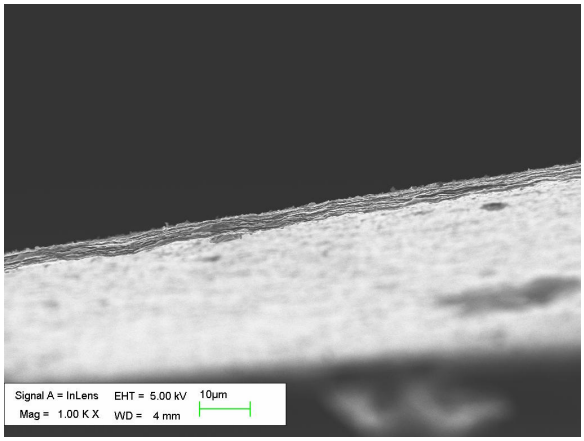



Figure S8. SEM image of the nanosheet sample for XRD characterization.