Electronic Supplementary Information for

Ultrathin Nanosheets of Feroxyhyte: A New Two-dimensional Material with Robust Ferromagnetic Behavior

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S1. SEM, TEM and AFM images of the synthetic $Fe(OH)_2$ nanosheets

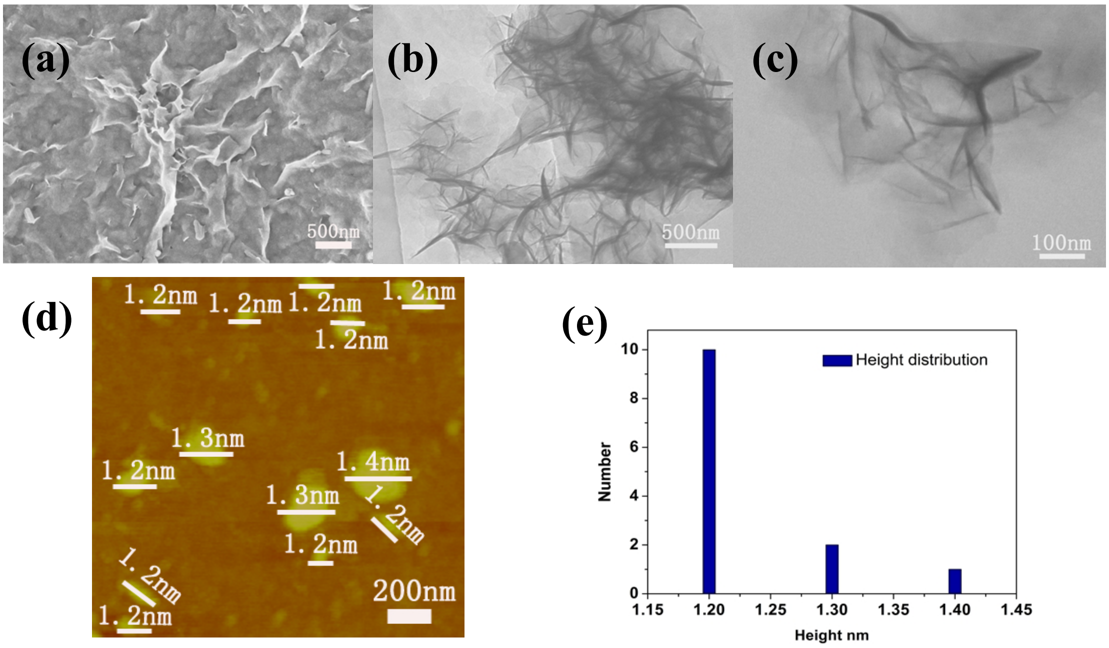

Figure S1. (a) SEM image of the $Fe(OH)_2$ precursor. (b) and (c) TEM images of the $Fe(OH)_2$ precursor. (d) AFM image of $Fe(OH)_2$ precursor . (e) the corresponding height distribution.

S2. The IR image of the δ-FeOOH ultrathin nanosheets

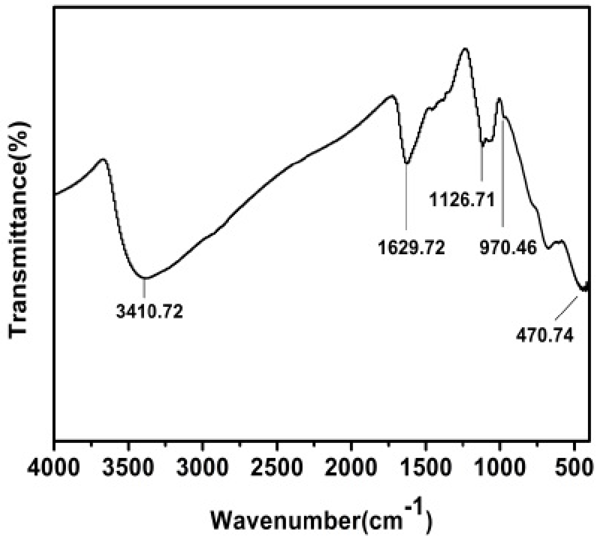

Figure S2. The IR image of the synthetic δ-FeOOH ultrathin nanosheets.

The IR spectrum is shown in Figure S2, the peaks at 470.74 cm^{-1} could be ascribed to Fe-O stretching vibaration of the δ-FeOOH, while the Fe-O-H bending mode is recorded at 1126.71cm^{-1} and a bridge between two iron ions through the OH group exhibits the bridging OH bending mode at 970.46cm^{-1} .The band at 3415.20cm^{-1} was attributed to stretching vibarations of surface H_2O molecules that were adsorbed on the synthetic δ-FeOOH ultrathin nanosheets and 1629.72cm^{-1} was ascribed to H_2O-bending vibaration.[1]

S3. XPS survey spectrum

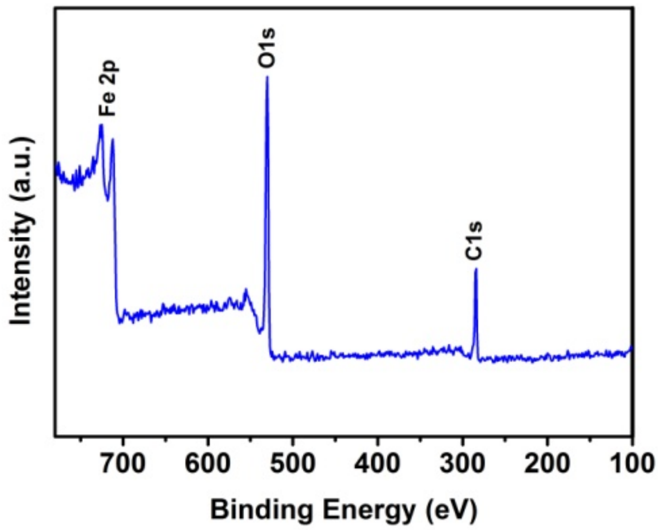

Figure S3. XPS survey spectrum of the δ-FeOOH ultrathin nanosheets.

S4. SEM and TEM images of the synthetic δ-FeOOH nanosheets

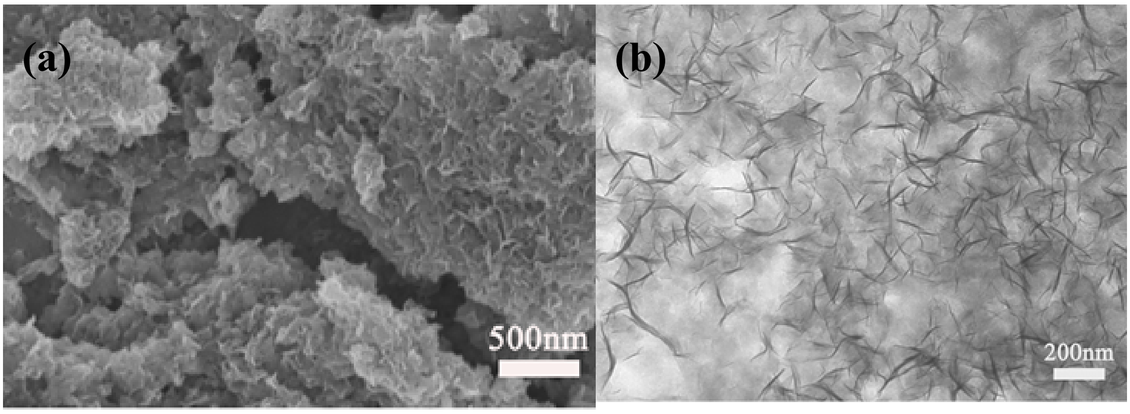

Figure S4. (a) SEM image and (b) TEM image of the as-syntheitc ultrathin δ-FeOOH nanosheets.

S5. The comparision of different TEM images of the δ-FeOOH nanosheets obtained in the mixture with and without EG

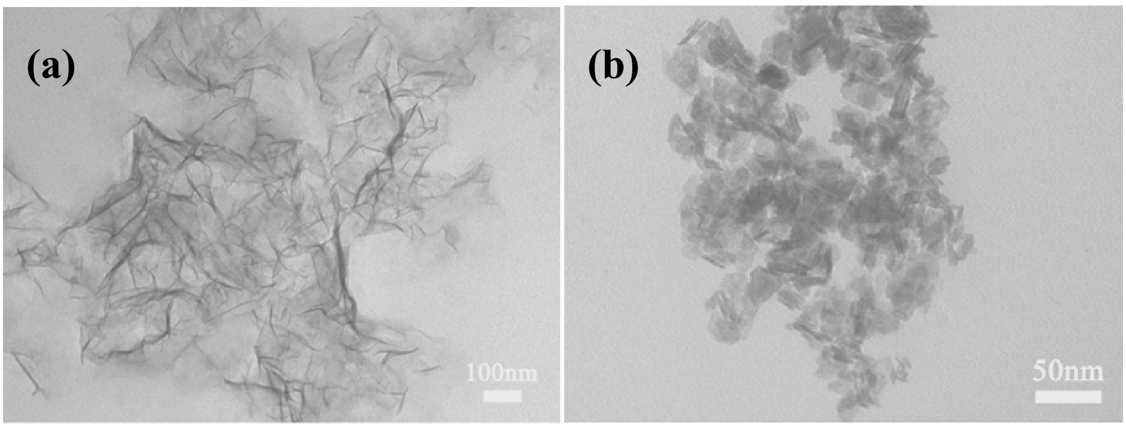

Figure S5. (a) TEM image of the ultrathin δ-FeOOH nanosheets prepared in EG-H_2O mixture and (b) TEM image of the δ-FeOOH nanoparticles obtained from the pure H_2O solution.

S6. Elemental Mapping of the as-synthetic δ-FeOOH ultrathin nanosheets.

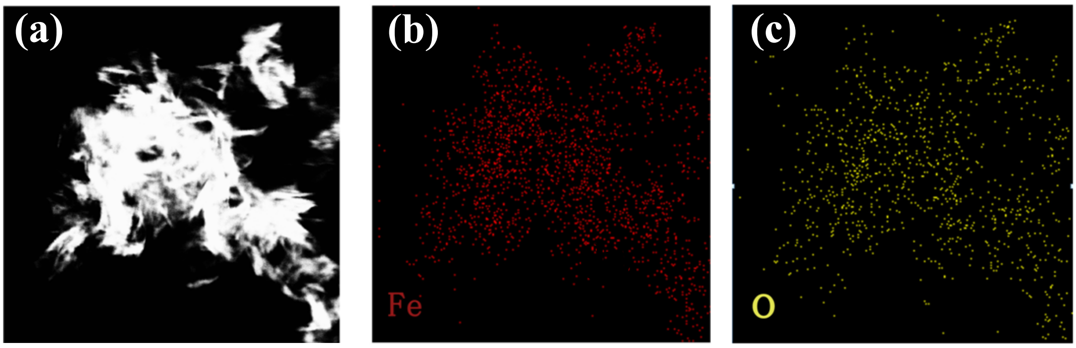

Figure S6. (a) HAADF-STEM image for typical δ-FeOOH ultrathin nanosheets. (b, c) elemental mapping of Fe, O.

S7. Characterization of *δ*-FeOOH nanosheets thin film

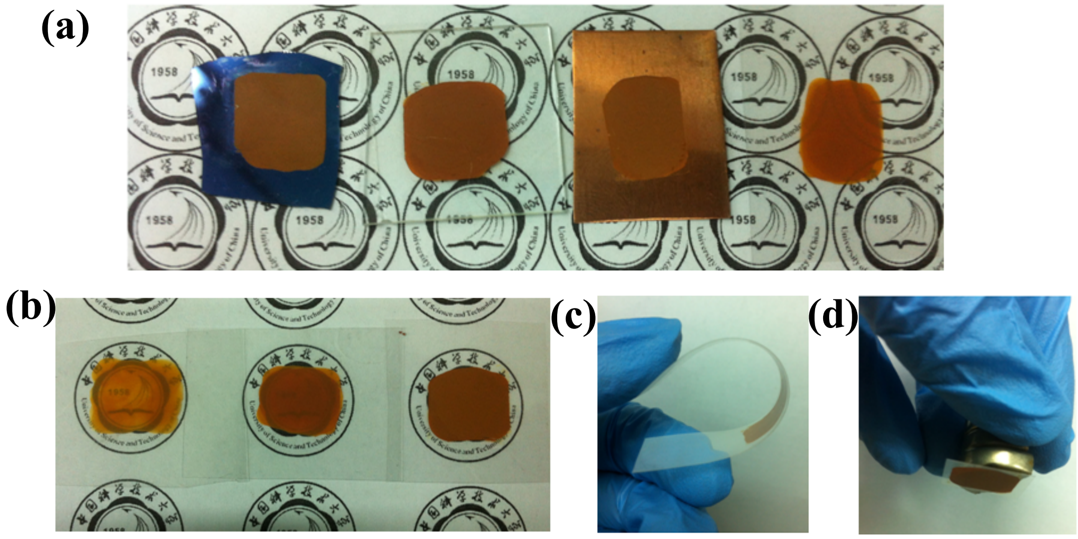

Figure S7. (a) The as-prepared *δ*-FeOOH thin film could be readily transferred to various substrates (silicon, quartz, copper, and PET respectively). (b) The photograph of *δ*-FeOOH thin film with different thickness transferred onto flexible PET substrates and (c) bend crooked *δ*-FeOOH film/PET, indicating the flexibility. (d) The photograph of *δ*-FeOOH thin film/PET absorbed by a magnet in vertical direction, demonstrating its robust room-temperature ferromagnetism.

S8. The UV-Vis spectrum of the δ-FeOOH ultrathin nanosheets

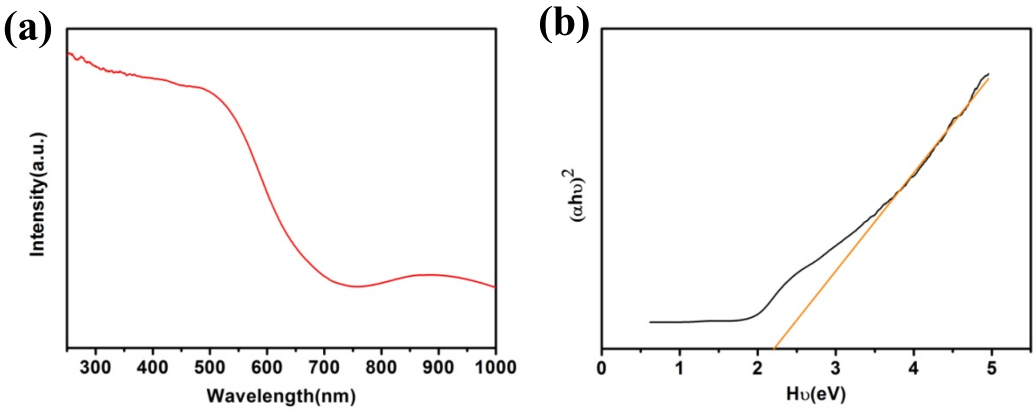

Figure S8. (a) UV-Vis absorption spectrum of the synthetic δ-FeOOH ultrathin nanosheets. (b) The plots of $(\alpha h\nu)^2$ versus $h\nu$, which was calculated from the UV-Vis diffuse reflectance spectrum.

The UV-Vis absorption spectrum of the synthetic δ-FeOOH ultrathin nanosheets was shown in Figure S8a. The broad absorption in the range of 250nm ~600nm of the figure S8a indicates a stronge absorption in both the Vis-light and UV region for the as-synthetic δ-FeOOH ultrathin nanosheets. The optical absorption near the band was calculated from the Figure S8a by using the following equation : $\alpha h\nu=A(h\nu-E_g)^{n/2}$. Where A is a constant, α is absorption coefficient, ν is light frequency, E_g is band gap, n depends on the kinds of direct-gap (n=1) and indirect gap (n=4) semiconductor in a material. Therefore, based on the detailed calculation of the UV-Vis experimental data, the synthetic δ-FeOOH ultrathin nanosheet is a direct-gap semiconductor with a band gap of 2.2eV.[2]

Table S1. Comparison of saturation magnetization of the reported ferromagnetic nanosheets

Materials selection	Measure temperature	Saturation magnetization	Ref#
Mn-Bi_2Te_3	5K	0.074 **emu/g**	3
Graphene	1.8K[a] 300K[b]	0.007 **emu/g**[a] 0.013 **emu/g**[b]	4,5
Graphene oxide	2K	0.11 **emu/g**	6
N- Graphene oxide	2K	1.66 **emu/g**	6
H-Graphene	300K	0.006 **emu/g**	7
SnO_2	300K	0.0244 **emu/g**	8
MoS_2	300K	2 **emu/g**	9
VS_2	300K	0.09 **emu/g**	10
VSe_2	300K	0.008 **emu/g**	11
Co_9Se_8	300K	1.7 **emu/g**	12
δ-FeOOH	300K	7.5 **emu/g**	Present work

Reference

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