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Supporting Information

Stöber-like Method to Synthesize Ultralight, Porous, Stretchable Fe_2O_3/Graphene Aerogels for Excellent Photo-Fenton Reaction and Electrochemical Capacitors

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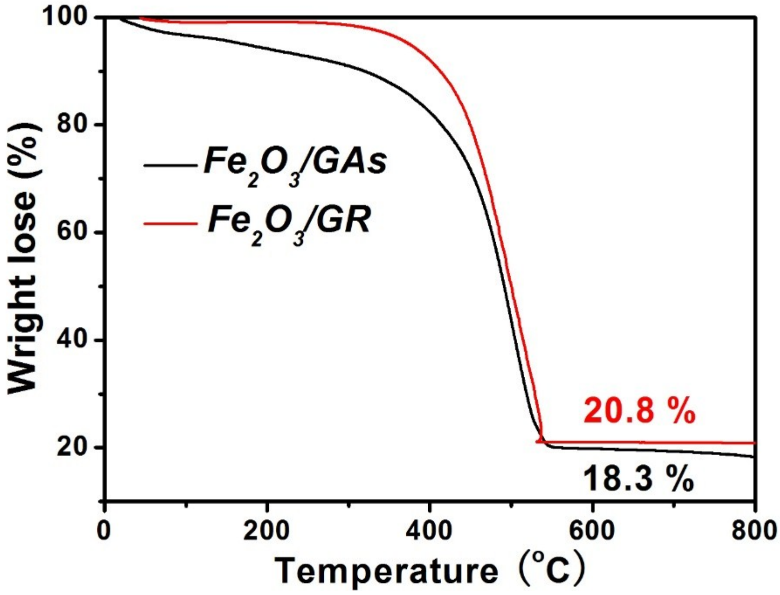

Figure S1. A typical TGA curve obtained for the Fe_2O_3/GAs and Fe_2O_3/GR under O_2 atmosphere.

Seen from the TGA results, Fe_2O_3/GAs is approximately 18.3 wt% weight loss observed near 550°C. To the pure Fe_2O_3 involved in the Photo-Fenton reaction, its mass is 0.042 g which is much higher than the mass of Fe_2O_3 in Fe_2O_3/GAs (0.0077g), that is, the actual activity for Fe_2O_3/GAs is much higher than the pure Fe_2O_3 under the condition of the same quality of Fe_2O_3. The reference sample of Fe_2O_3/GR contains 20.8 wt% Fe_2O_3, which is close to the Fe_2O_3/GAs.

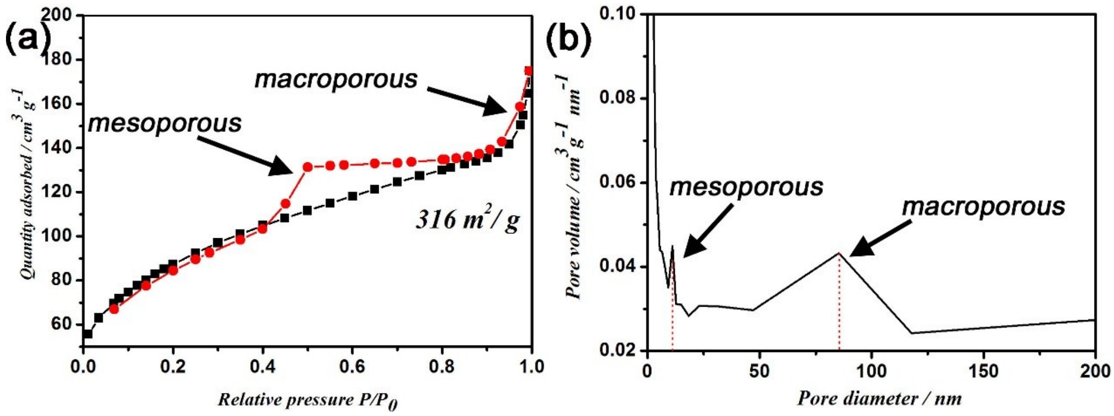

Figure S2. (a) Nitrogen adsorption-desorption isotherms of Fe_2O_3/GAs, and (b) its corresponding pore size distribution curves.

The nitrogen adsorption-desorption isotherm of Fe_2O_3/GAs indicates that the BET surface area is 316 m^2/g and the Fe_2O_3/GAs possess the typical mesoporous and macroporous structure. The mesoporous size is mainly in the range of 10-13 nm, and the macroporous size is in the range of 50-120 nm, consistent with SEM results. The mesoporous structure comes from the stacking pores between Fe_2O_3 nanocrystals, and the macroporous structure is induced by the hydrothermal self-assembly of graphene oxide to form a GAs.

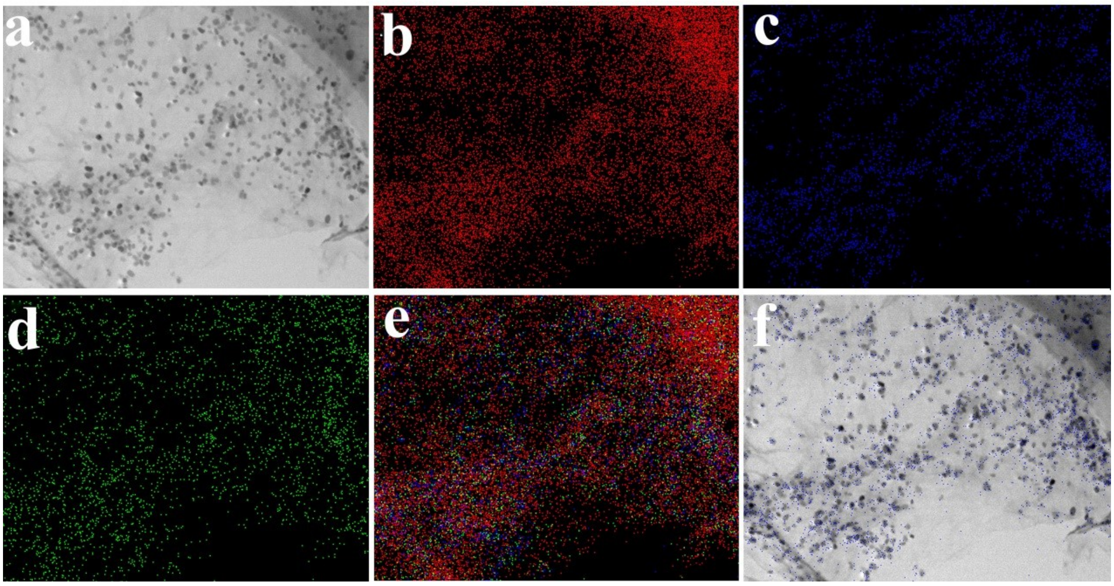

Figure S3. (a) The TEM image, (b) C element, (c) Fe element, (d) O element, (e) the overlapping of C, Fe and O elements, and (f) the overlapping of Fe and TEM image mapping images of Fe_2O_3/GAs.

The distribution profile of C elements in TEM mapping is consistent with the profile of graphene sheets, and the profile of Fe element is overlapping with the Fe_2O_3 nanocrystals in the TEM image, verifying the ultradispersed distribution of Fe_2O_3 nanocrystals on the GAs surface. The overlapping of the profiles of Fe, O, C elements in the mapping also indicates the ultradispersed distribution of Fe_2O_3 nanocrystals.

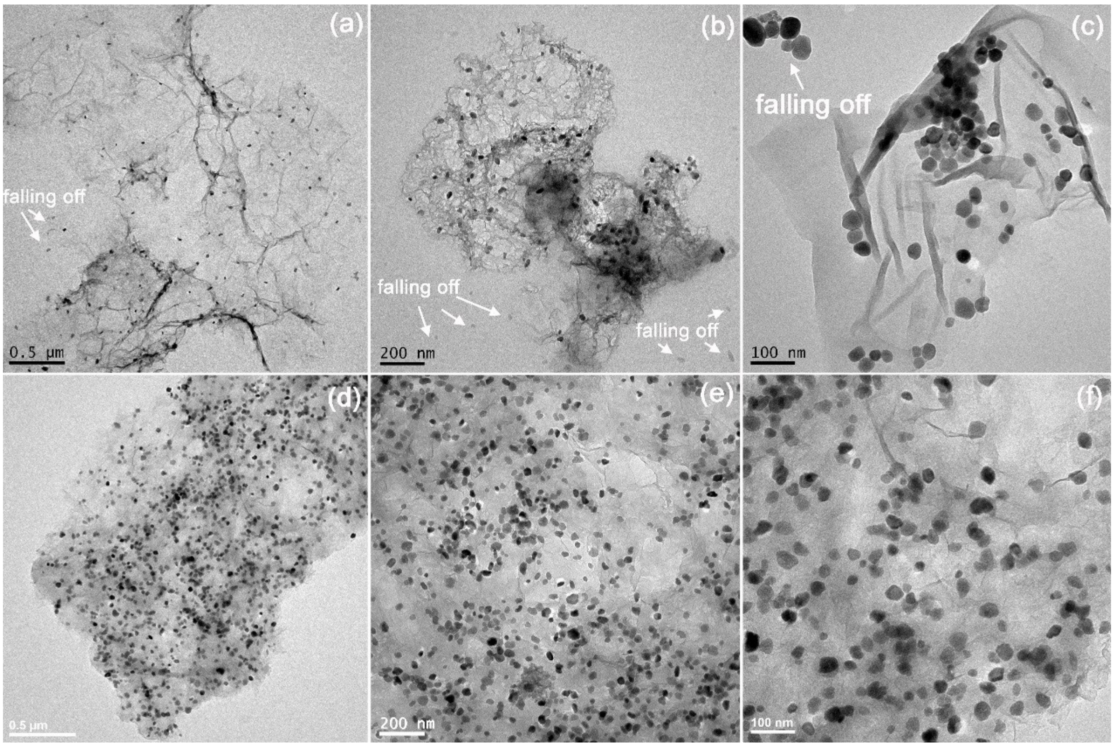

Figure S4. TEM images of (a) Fe_2O_3/GAs prepared by a direct hydrothermal method without a modified Stöber-like treatment, and (b) Fe_2O_3/GAs prepared by a modified Stöber-like pretreatment and followed by a hydrothermal treatment.

If the Fe_2O_3/GAs was prepared by a one-step hydrothermal method, there was only a little amount of Fe_2O_3 nanoparticles loaded on the surface of GAs, and many Fe_2O_3 nanoparticles were falling off from the GAs. That means the connection between Fe_2O_3 and GAs was very poor. However, when we used a modified Stöber-like technology to pretreat the composite, it would make the Fe_2O_3 crystals seeds in situ growth on the surface of GAs, and ensured that most of Fe_2O_3 nanoparticles were strongly embedded on the surface of GAs.

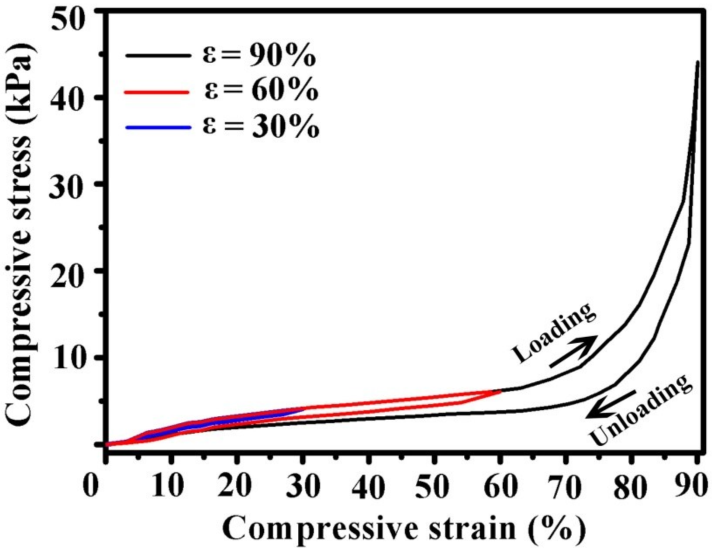

Figure S5. Compressive stress–strain curves of a CNF aerogel at different set strain ε of 30, 60, and 90%.

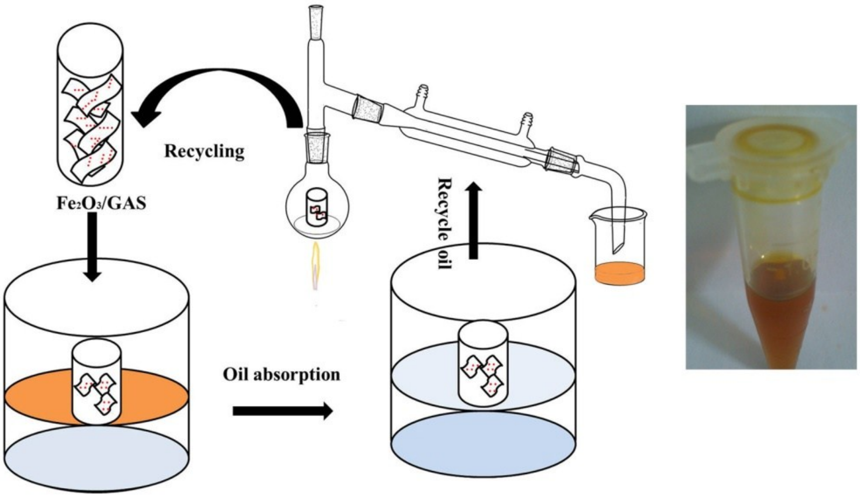

Figure S6. Schematic illustration of the recycle the Fe_2O_3/GAs and the oil by the one-step distillation method.

Except to the burning method, some other methods also can be used to recycle the GAs, such as the distillation. We got out the Fe_2O_3/GAs from the oil-water mixture and put the GAs in the distilling apparatus. After heating the GAs at the boiling point temperature of pump oil for a certain period of time, the oil can be condensed in a beaker. The recovery yield can be more than 95%.

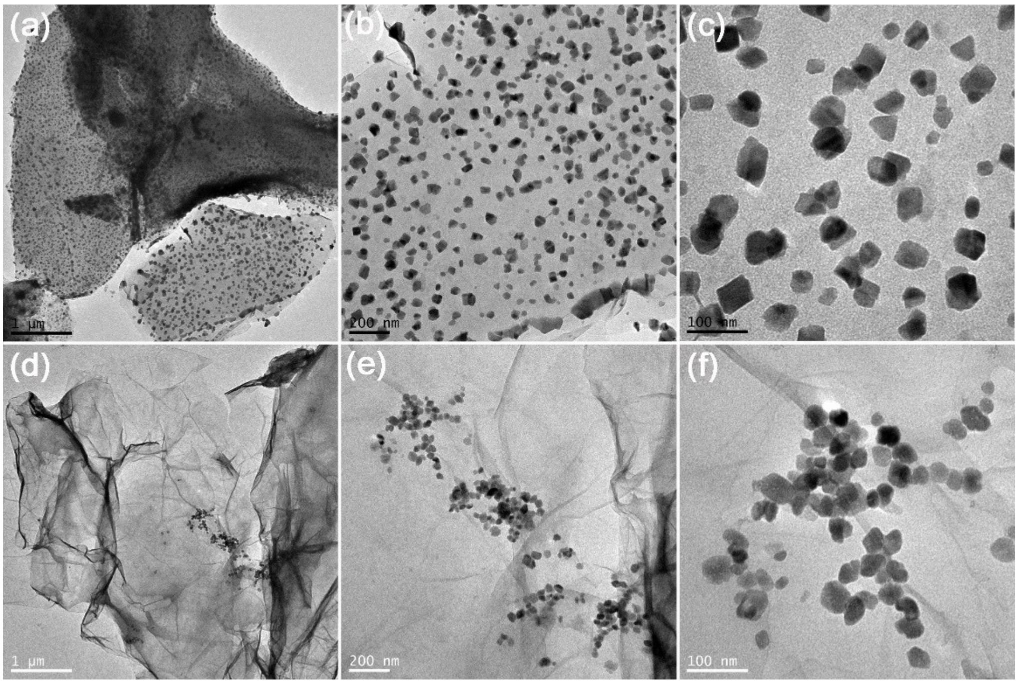

Figure S7. (a, b, and c) TEM images of 2D structured Fe_2O_3/GR, and (d, e, and f) its TEM images after 8 times cycling test.

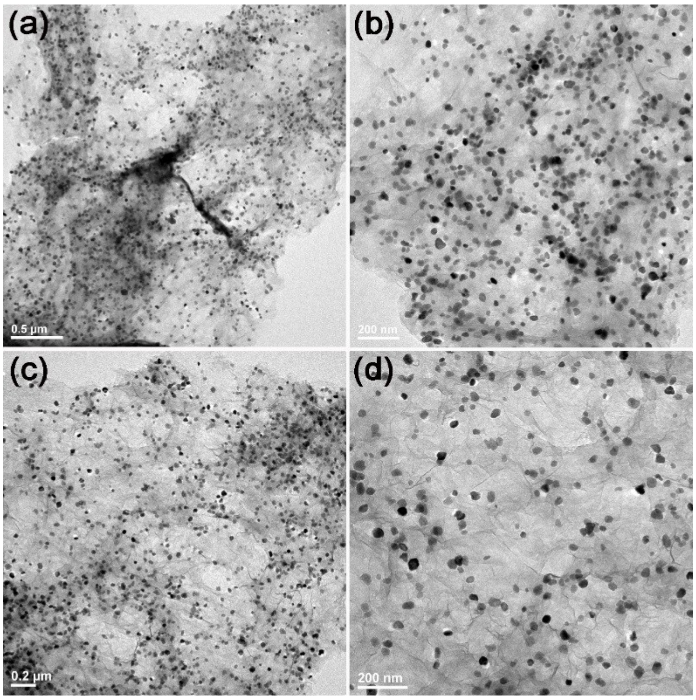

Figure S8. (a and b) TEM images of the Fe_2O_3/GAs after 5 times cycling test and (c and d) 10 times cycling test.

Seen from the TEM images of Fe_2O_3/GAs after the cycling test, the size and the distribution of Fe_2O_3 nanocrystals on the GAs surface are all changeless. The results indicate that the Fe_2O_3 nanocrystals in situ growth on the GAs is much more stable than the pure Fe_2O_3 involved in the Photo-Fenton system. The Fe_2O_3/GAs is an ideal support to transfer the photo-generated charges and protect the losing of Fe^{3+}. The excellent conversion between Fe^{3+}/Fe^{2+} on the surface of graphene makes the Fe_2O_3/GAs giving an extremely high and stable Fenton degradation of MO in a wide pH range.

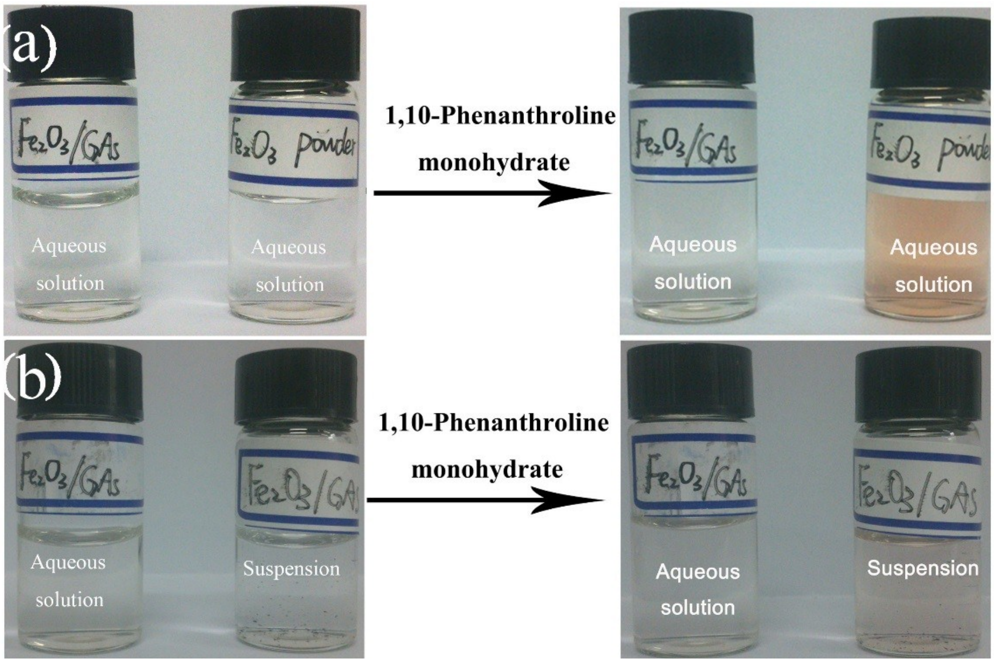

Figure S9. (a) Photographs of the filterable reaction liquid of Fe_2O_3 powders and Fe_2O_3/GAs in the presence of 1, 10-phenanthroline monohydrate (Phen, the initial pH was 3.5). (b) Photographs of the suspension of Fe_2O_3/GAs in the presence of Phen (the initial pH was 3.5). We cut out a small piece of Fe_2O_3/GAs which is got out from the Fenton reaction system, and then grinded it to be the powders. The powders were dispersed into the filterable reaction liquid in the presence of Phen to obtain the suspension of (b).

To the filterable reaction liquid from different catalysts in Photo-Fenton reaction, the filterable liquid of Fe_2O_3 powders gives a noticeable range color after adding with Phen, indicating the Fe^{2+} ions dissolving out from the Fe_2O_3 surface. The dissolved Fe^{2+} demonstrate the Fe^{3+}/Fe^{2+} cycle reaction is mainly occurring in the aqueous solution. Different from that, the color of filterable liquid of Fe_2O_3/GAs is changeless in presence of Phen, suggesting the absence of Fe^{2+} in the solution. That means, the Fe^{3+}/Fe^{2+} cycle reaction is not occurring in the solution for the Fe_2O_3/GAs system. We cut out a small piece of Fe_2O_3/GAs and then grinded it to be the powders, which were dispersed in the reaction liquid to obtain a suspension. After adding the Phen in the suspension, its color changes to orange, which indicates the Fe^{2+} ions are mainly located on the GAs surface. Hence, we can conclude that the Fe^{3+}/Fe^{2+} cycle is mainly occurring in the GAs for the Fe_2O_3/GAs system. The excellent charge transfer property of GAs will help the enhancing of Fe^{3+}/Fe^{2+} cycle reaction rate and improve the utilization of H_2O_2 and the stability of Fe_2O_3/GAs in the Photo-Fenton reaction.

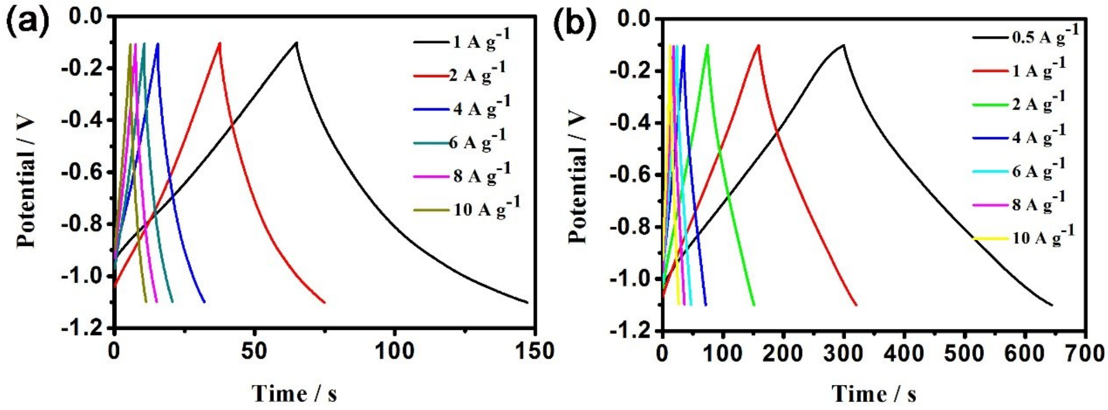

Figure S10. Galvanostatic (GS) charge/discharge curves of (A) Fe_2O_3/GR and Fe_2O_3/GAs hybrids at different current densities.

Movie S1. The movie of the compression test on the Fe_2O_3/GAs.

The Fe_2O_3/GAs can withstand for dozens times of compression test, indicating its excellent mechanical strength and elastic property.

Movie S2. The movie of the impedance changing on the Fe_2O_3/GAs during the compression process.

The impedance of Fe_2O_3/GAs decreases gradually with the gradual compressing of GAs, indicating the excellent conductivity of Fe_2O_3/GAs and its large potential application in the electrochemistry devices.

Movie S3. The movie of the adjustment of the speed of the fan by using Fe_2O_3/GAs as the electrically controlled switch.

We used the Fe_2O_3/GAs to successfully achieve the adjustment of the rotated speed of the fan. With the gradual compressing of Fe_2O_3/GAs, the fan gave a gradual increased rotating speed. With the gradual release of Fe_2O_3/GAs, the fan gave a gradual decreased rotating speed. That means the Fe_2O_3/GAs has a large potential application in designing some controllable electrochemistry devices.

Movie S4. The movie of the pump oil absorption test on the Fe_2O_3/GAs.

Although a large number of Fe_2O_3 nanocrystals were introduced into the GAs 3D-network structure, it still remains the excellent oil absorption capacity. The Fe_2O_3/GAs can completely adsorb pump oil within 20 seconds.

Movie S5. The movie of the thermal stability of Fe_2O_3/GAs after adsorption of pump oil.

Fe_2O_3/GAs can be recycled by burning off the oil. After the burning, the GAs remains a changeless appearance and can be used again to the oil adsorption, which indicates that the Fe_2O_3/GAs has certain of thermal stability capacity.