Electronic supplementary information (ESI) for

New versatile Pt supports composed of graphene sheets decorated by Fe₂O₃ nanorods and N-dopants with high activity based on improved metal/supports interaction

Yunqian Dai,¹,* Yunling Chai,¹ Yibai Sun,¹ Wanlin Fu,¹ Xiaotian Wang,¹ Qing Gu,¹ Tingying Helen Zeng² and Yueming Sun¹,*

¹School of Chemistry and Chemical Engineering, Southeast University, Nanjing, Jiangsu 211189, P. R. China
²Center for Excitonics, Research Laboratory for Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

* Corresponding author: daiy@seu.edu.cn and sun@seu.edu.cn

Experimental

1. Chemical and materials

Poly(vinyl pyrrolidone) (PVP, M_w ≈ 1.3×10⁶ or 5500), acetic acid (CH₃COOH, glacial), Iron(III) acetylacetonate (Fe((Cs₅H₇O₂)₃), Fe(acac)₃), chloroplatinic acid hydrate (H₂PtCl₆·xH₂O, 99.995%), sodium borohydride (NaBH₄, 99.99%), and ammonium hydroxide (NH₄OH, 28-30 wt%) were obtained from Sigma-Aldrich. Graphite powder (99.95%, 325 mesh) was obtained from Alfa Aesar. And all other chemicals were obtained from Sinopharm Chemical Reagent Co., Ltd. All chemicals were used as received. The water used in all experiments was filtered through a Millipore filtration system with a resistivity of 18 MΩ cm.

2. Electrospinning of Fe₂O₃ nanofibers
The PVP/Fe(acac)_3 composite nanofibers were prepared by electrospinning a precursor containing 0.8 g of Fe(acac)_3, 0.4 g of PVP (M_w ≈ 1.3×10^6), 3 mL of ethanol and 3.5 mL of acetic acid. The flowing rate was 0.4 mL/h, and a voltage of 15 kV was applied by a high-voltage DC supply. The as-spun PVP/Fe(acac)_3 nanofibers were kept in air overnight and then converted to Fe_2O_3 nanofibers after a calcination at 600 °C for 4 h in the air.

3. Fabrication of Fe_2O_3/N-RGO nanosheets

Graphene oxide colloid was fabricated by a modified Hummer’s method. 1 4 mg of graphene oxides (GO) and 16 mg of Fe_2O_3 nanofibers were added into 15 mL Millipore water followed by a mild sonication. After adding 5 mL of ammonium hydroxide (NH_4OH), the suspension was carefully transferred into a Teflon-line stainless-steel autoclave, and then heated to 200 °C for 8 h. Finally, The Fe_2O_3/N-RGO nanosheets precipitates were purified by water at three times and dried at 80 °C overnight.

4. Selective photodeposition of Pt nanoparticles on Fe_2O_3/N-RGO supports driven by visible-light irradiation

1.6 mg of Fe_2O_3/N-RGO hybrid sheets was initially redispersed in 2 mL of water followed by adding 2 mL of methanol. 0.5 mL of aqueous PVP (M_w≈ 5500, 11.3 mg/mL) and H_2PtCl_6 (8.3 mg/mL) solutions were then added into the suspension simultaneously. Finally, the suspension was irradiated under visible light (λ>420 nm) with magnetic stirring. The as-prepared Pt/Fe_2O_3/N-RGO ternary catalysts were then thoroughly washed by water six times to remove excess PVP and individual Pt nanoparticles.

5. Catalytic performance testing

As a model reaction, we chose the reduction of 4-nitrophenol to 4-aminophenol by NaBH_4 to estimate the catalytic activities. In a typical procedure, 25 μL of 4-nitrophenol (7.4 mmol/L) and 25 μL of NaBH_4 (2.4 mol/L) were added into 1.25 mL of Millipore water. Then, a given amount of the ternary catalysts were quickly added into the system to start the catalytic reaction. The initial concentration of 4-nitrophenol, NaBH_4 and Pt were set to 1.42×10^{-4}, 4.62×10^{-2} and 1.18×10^{-6} mol/L,
respectively. The kinetic process of the reduction was monitored by measuring the adsorption of the solution at 400 nm as a function of time. After each round of reaction, another 25 μL of 4-nitrophenol (7.4 mmol/L) and 25 μL of NaBH₄ were added to the reaction solution. This step was repeated five times to evaluate the recoverability of catalysts.

6. Characterizations

TEM images were collected using a transmission electron microscope (Tecnai G2 T20, FEI) operated at 200 kV. The crystal structure information was obtained with X-ray diffraction (Bruker, D8 advance using Cu-Ka radiation, λ=1.5406 Å). X-ray photoelectron spectroscope (XPS) measurements were performed with a Thermo Scientific K-Alpha using monochromatic Al Kα radiation. The magnetic measurements were conducted using a Vibrating Sample Magnetometer (VSM) up to a magnetic field of ±90 kOe, in a Physical Property Measurement System (PPMS-9, Quantum Design) at room temperature. The Pt mass was determined by Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) (Optima 7300DV, Perkin Elmer Corporation). The UV-vis spectra were recorded on a Shimadzu UV-2450 spectrophotometer.
Figure S1. (A) TEM image and (B) XRD patterns of electrospun Fe₂O₃ nanofibers. The XRD patterns match those of hematite (alfa-Fe₂O₃) phase (JCPDS No. 33-0664).
Figure S2. TEM images of the free PVP-stabilized Pt nanoparticles, made by a polyol method.
Figure S3. The extinction spectra of 4-nitrophenol solution after adding (A) Fe$_2$O$_3$/N-RGO sheets, (B) N-RGO sheets and (C) Fe$_2$O$_3$, suggesting the reduction of -NO$_2$ group to -NH$_2$ group due to the catalytic ability of N-RGO sheets.
Figure S4. The normalized extinction at 400 nm for the 4-nitrophenol reduction after adding Pt/FeO$_3$ nanorods, which had a smaller $k_1$ of 7.98 s$^{-1}$ mg$^{-1}$. 
Table S1 Comparison of rate constants ($k_1$) of high performance Pt nanoparticles loaded on different supports for 4-nitrophenol reduction

<table>
<thead>
<tr>
<th>Sample</th>
<th>Pt size/nm</th>
<th>$k_1$/s$^{-1}$.mg$^{-1}$</th>
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<tr>
<td>Pt/Fe$_2$O$_3$/N-RGO</td>
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<td>This work</td>
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<tr>
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</table>

Date were given or calculated in the respective references.
**Figure S5.** Plots of $k_1$ against the successive reaction cycles using Pt/Fe$_2$O$_3$/N-RGO sheets in Fig. 2C as the catalysts.

**References**