Supporting information

PtFe Nanoparticles Supported on Electroactive Au-PANI Core@Shell Nanoparticles for High Performance Bifunctional Electrocatalysis

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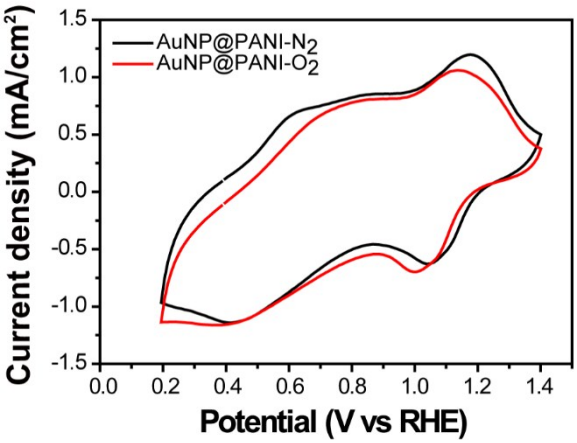

Fig. S1 Cyclic voltammograms (CVs) of AuNP@PANI in a N_2 and O_2-saturated 0.1 M $HClO_4$ solution.

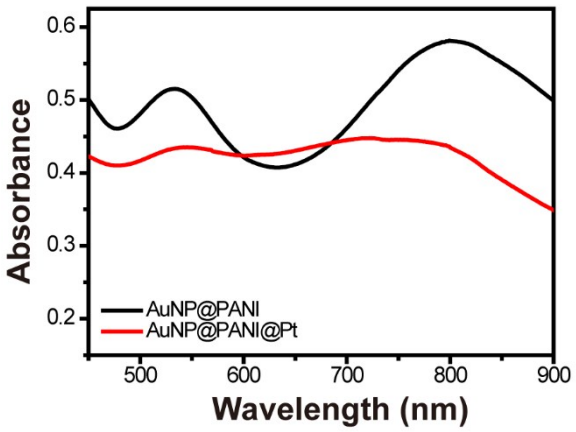

Fig. S2 UV-Vis spectra of AuNP@PANI (black curve) and AuNP@PANI@Pt (red curve) nanostructures with aniline/Pt molar ratio of 1:1.

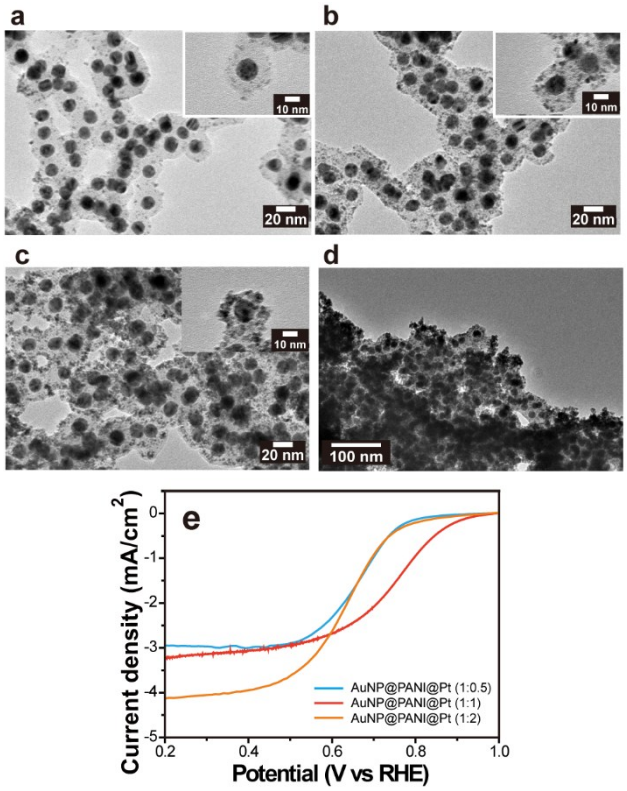

Fig. S3 TEM images of AuNP@PANI@Pt nanostructures synthesized at different molar ratio of aniline and platinum precursor: (a) 1:0.2, (b) 1:0.5, (c) 1:1 and (d) 1:2. (f) LSVs of AuNP@PANI@Pt nanostructures. LSVs were recorded in O_2-saturated 0.1 M $HClO_4$ at 1600 rpm and at a scan rate of 5 mVs^{-1}.

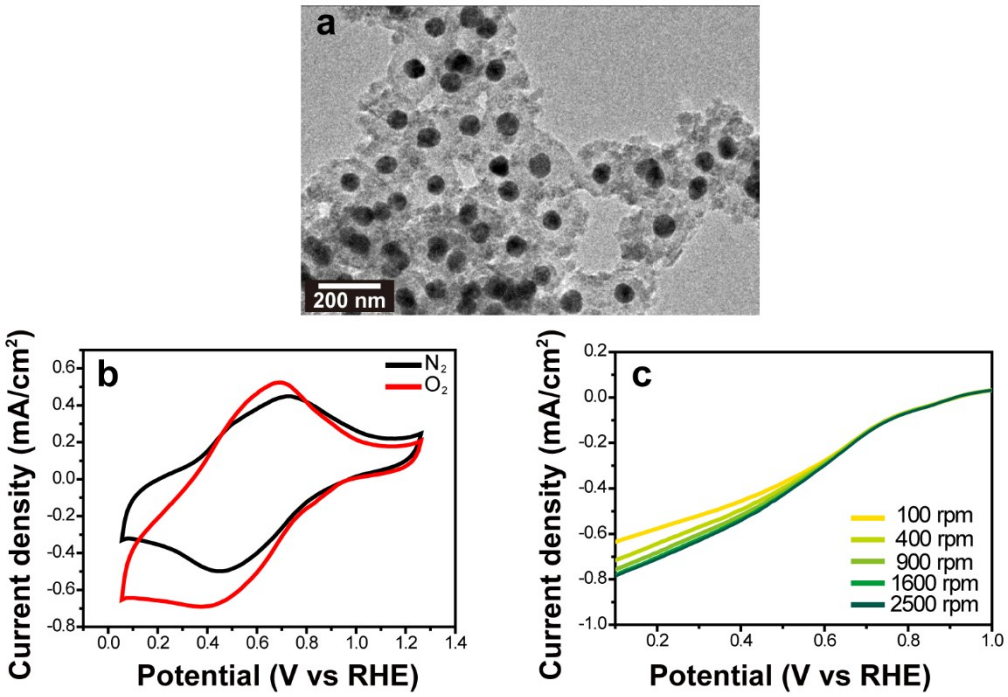

Fig. S4 TEM Image of AuNP@PANI@Fe (a); the cyclic voltammograms of AuNP@PANI@Fe (b) in a N_2 and O_2-saturated 0.1 M $HClO_4$ solution; linear sweep voltammograms of AuNP@PANI@Fe (c) in oxygen-saturated 0.1 M $HClO_4$ at various rates (100, 400, 900, 1 600 and 2 500 rpm) and potential scan rate 5 mVs^{-1}.

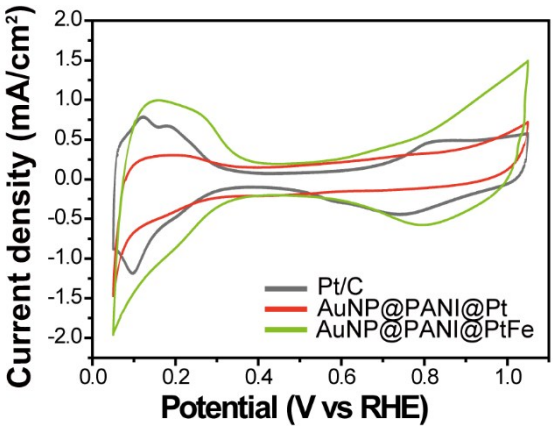

Fig. S5 Cyclic voltammograms of AuNP@PNAI@Pt and AuNP@PANI@PtFe in a N_2-saturated 0.1 M $HClO_4$ solution at a scan rate of 20 mVs^{-1}.

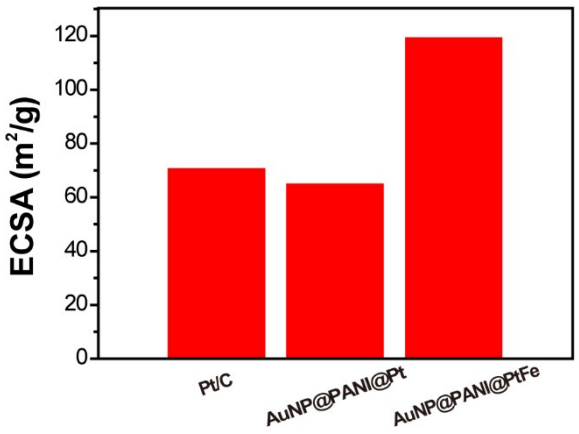

Fig. S6 Electrochemical surface areas (ECSA) determined after activity testing for electrochemical characteristics of voltammetrically AuNP@PANI@Pt and AuNP@PANI@PtFe.

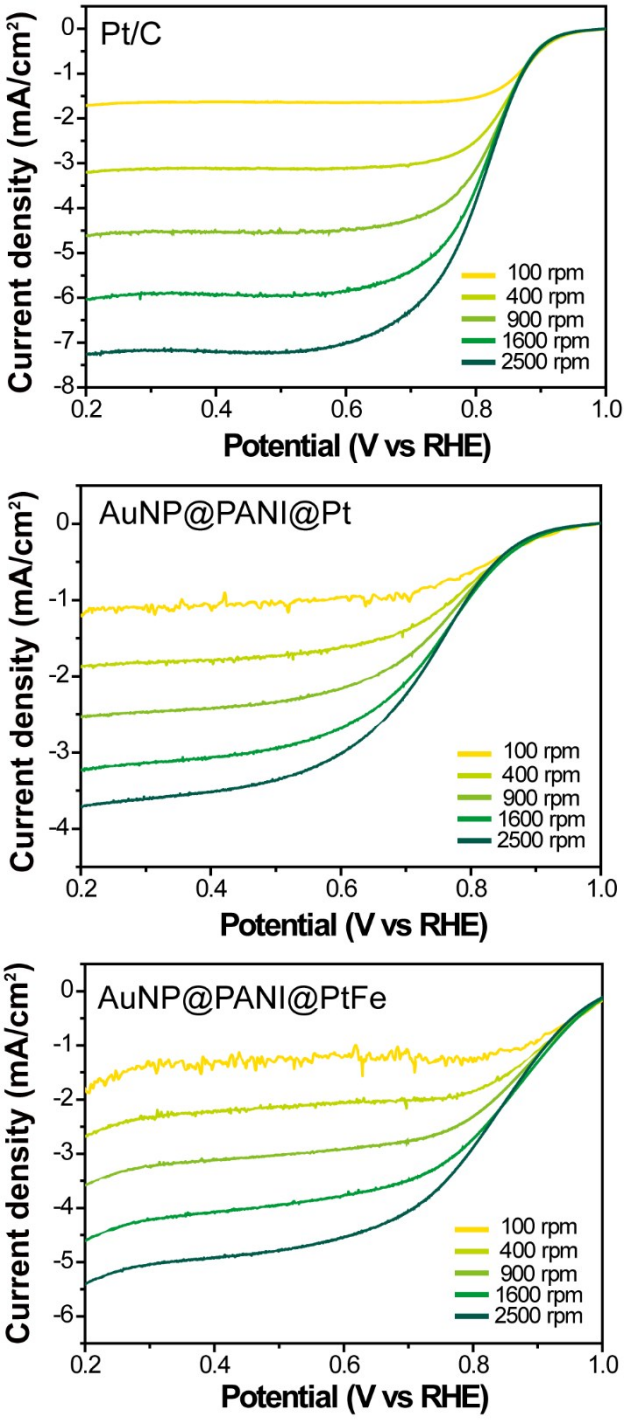

Fig. S7 LSVs of AuNP@PANI@Pt and AuNP@PANI@PtFe measured in O_2-saturated 0.1 M $HClO_4$ solution. The scan rate was 5 mVs^{-1} and the different rotation speed.

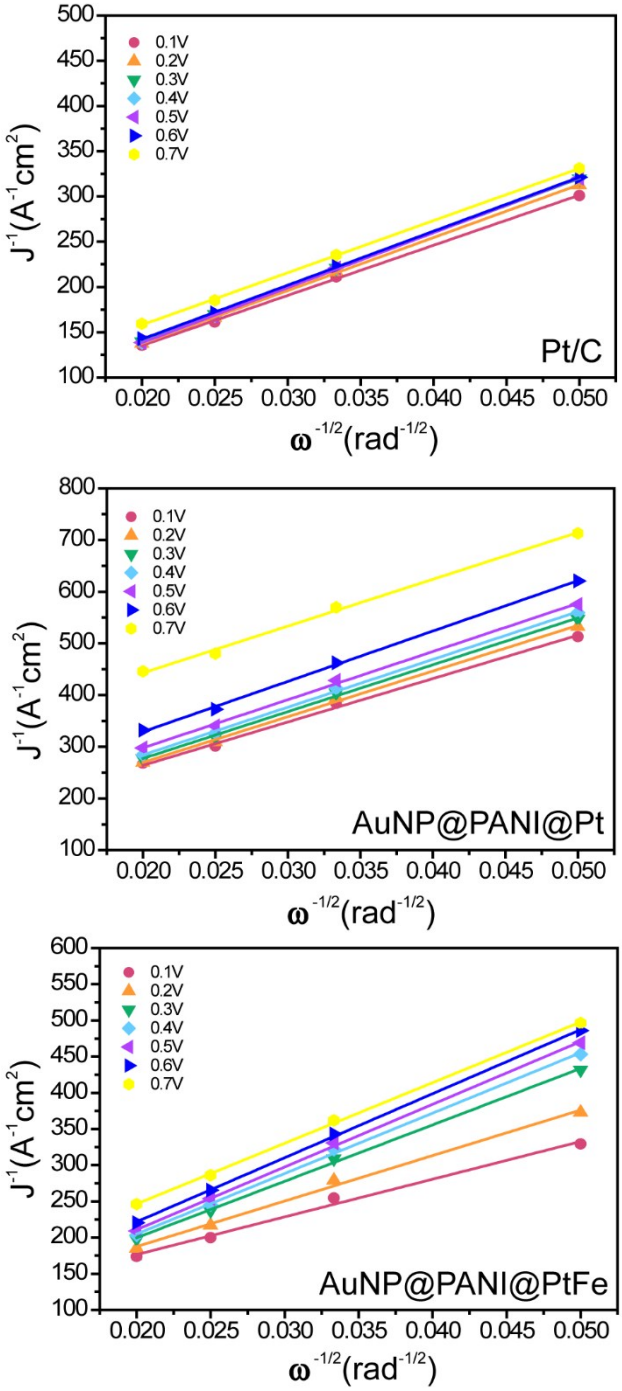

Fig. S8 Koutecky-Levich plots derived from the data in LSVs at different potential.

Potential / Sample	0.1V	0.2V	0.3V	0.4V	0.5V	0.6V	0.7V
Pt/C	3.77	3.57	3.48	3.42	3.44	3.5	3.63
AuNP@PANI@Pt	2.49	2.37	2.31	2.26	2.24	2.15	2.31
AuNP@PANI@PtFe	4.02	3.33	2.68	2.5	2.41	2.36	2.49

Table S1. Electron transfer number determined from fit lines of the Koutecky-Levich plots derived at different potential.

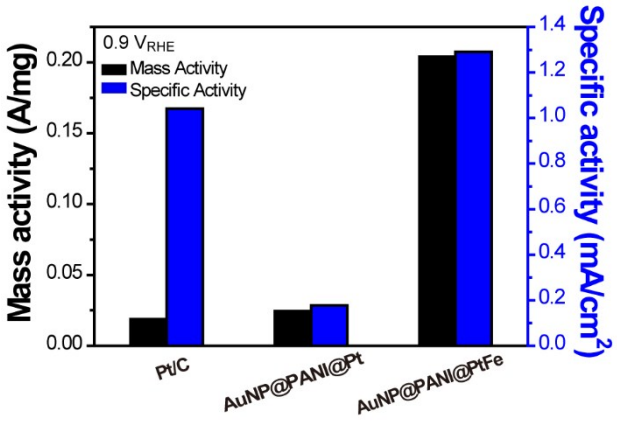

Fig. S9 The mass and specific activities for ORR performance at 0.90 V versus RHE obtained using AuNP@PANI@Pt and AuNP@PANI@PtFe.

Sample	Mass Activity (A/mg)	Specific Activity (mA/cm^2)	Ref.
AuNP@PANI@PtFe	0.21	1.29	This work
$FePt_3$/C	0.30	1.38	*Nano Lett.*, **2011**, 11, 919-926 [1]
PtFe Nanoparticles	0.27	0.54	*J. Phys. Chem. C* **2015**, 119, 3971-3978 [2]
PtFe@Pt/CNT	0.25	-	*RSC Adv.*, **2015**, 5, 66471-66475 [3]
fcc-PtFe/C	0.60	0.75	*J. Am. Chem. Soc.,* **2015**, 137, 15478-15485 [4]
fct-PtFe/C	1.50	2.25	*J. Am. Chem. Soc.* **2015**, 137, 15478-15485 [4]
PtFe/C	0.25		*Energy Environ. Sci.*, **2016**, 9, 2623-2632 [5]

Table S2. Summary of the reported ORR performance for PtFe catalysts at 0.90 V versus RHE in acidic media (0.1 M $HClO_4$).

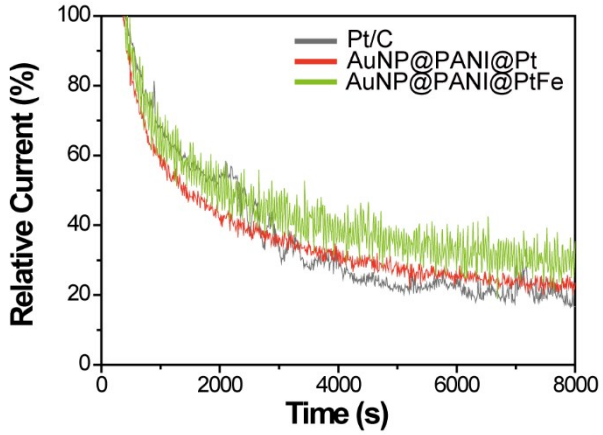

Fig. S10 The durability test of the catalysts by chronoamperometric measurement at 0.7 V for 8000 s.

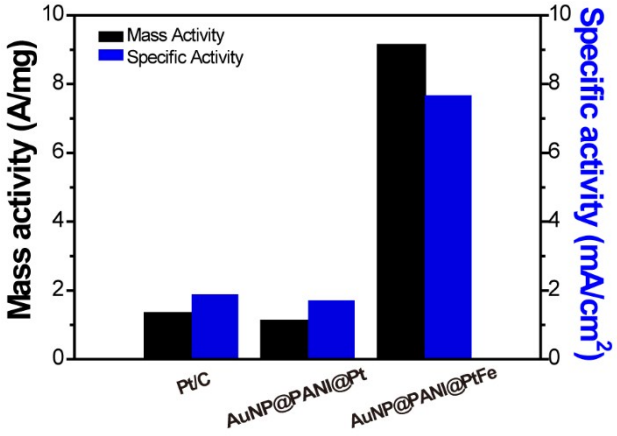

Fig. S11 The mass activity and specific activity of MOR performance for AuNP@PANI@Pt and AuNP@PANI@PtFe at 0.8 V versus RHE.

Sample	Mass Activity (A/mg)	Specific Activity (mA/cm^2)	j_f/j_b	Ref.
AuNP@PANI@PtFe	9.13 (@0.8 V vs RHE and @0.5 V vs SCE)	7.66	1.10	This work
PtFe/C	0.24 (@0.5V vs SCE)	1.30	-	*Electrochimica Acta* **2014**, 139, 61-68 [6]
PtFe@Pt	0.82 (@0.5 V vs SCE)	-	-	*Chem. Commun.*, **2015**, 51, 3215-3218 [7]
PtFe	0.55 (@0.65 V vs SCE)	2.03	1.01	*J. Mater. Chem. A*, **2015**, 3, 1182-1187 [8]
PtRuFe	1.14 (@0.65 V vs SCE)	1.74	1.41	*J. Mater. Chem. A*, **2015**, 3, 1182-1187 [8]
PtFe NCs	0.57 (@0.65 V vs SCE)	1.04	1.09	*Chem. Commun.*, **2016**, 52, 3903-3906 [9]
PtFeAu NCs	1.32 (@0.65 V vs SCE)	3.01	1.52	*Chem. Commun.*, **2016**, 52, 3903-3906 [9]
PtFe/CNT	-	-	1.14	*Fuel* **2016**, 182, 1-7 [10]

Table S3. Summary of the reported MOR performance for diverse PtFe catalysts.

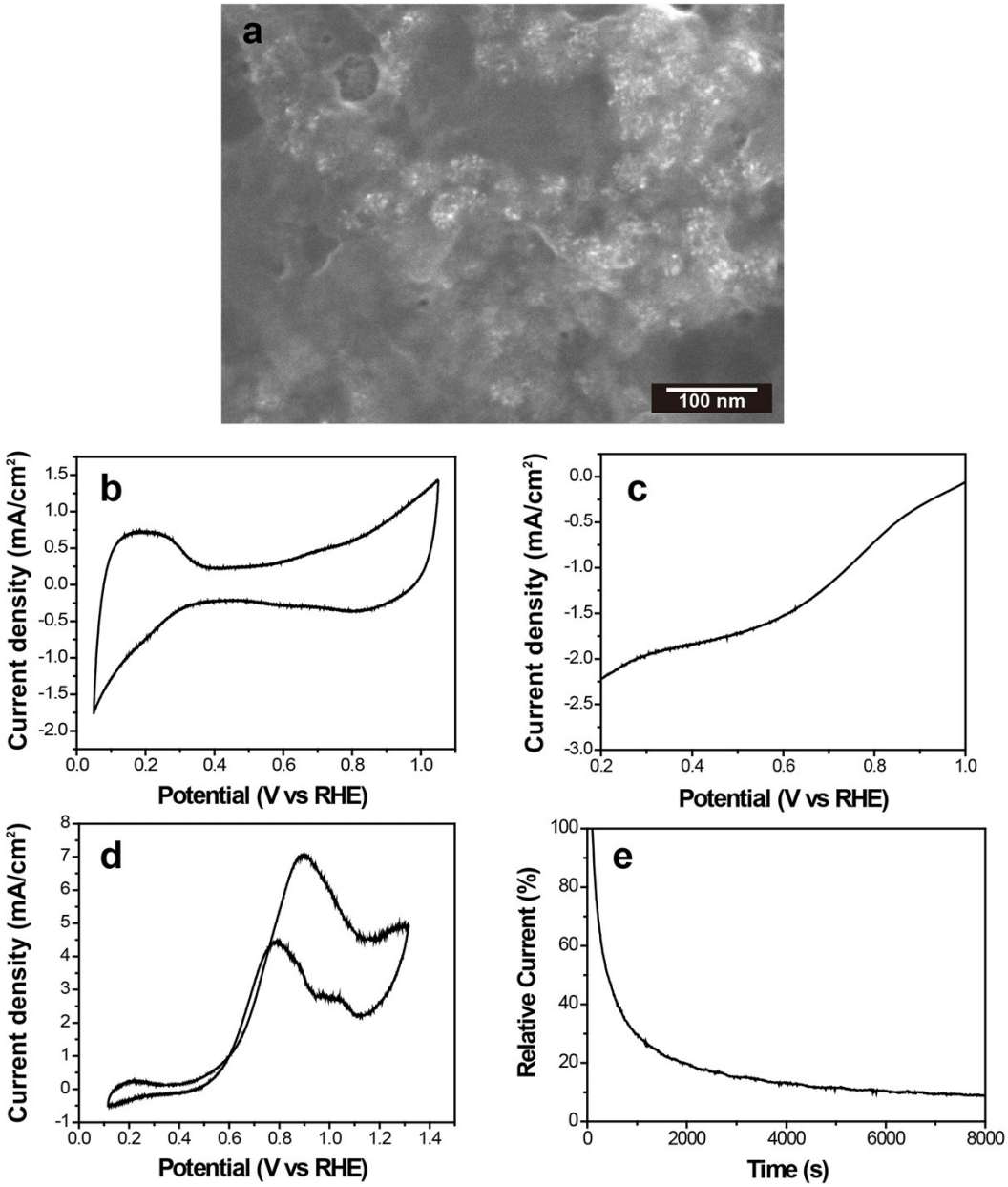

Fig. S12 SEM Image of PANI@PtFe catalyst (a); the CV of PANI@PtFe (b) in a N_2 saturated 0.1 M $HClO_4$ solution; LSV of PANI@PtFe catalyst (C) in O_2-saturated 0.1M $HClO_4$ at 1600 rpm and potential scan rate 5 mVs^{-1}; CV of PANI@PtFe (d) in 0.1 M $HClO_4$ + 0.1 M methanol at scan rate 20 mVs^{-1}; durability test of the PANI@PtFe by CA measurement (e) at 0.7 V for 8000 s.

References

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