Supporting Information

Highly dispersed Pd nanoparticles supported on nitrogen-doped graphene with enhanced hydrogenation activity

Ping Liu[a],*, Gen Li[a], Wan-Ting Chang[a], Meng-Yao Wu[a], Yong-Xin Li[a],*, Jun Wang[b]

[a]*Jiangsu Key Laboratory of Advanced Catalytic Materials and Technology, Institute of Petrochemical Technology, Changzhou University, Changzhou, Jiangsu 213164, China*

[b]*State Key Laboratory of Materials-oriented Chemical Engineering, College of Chemistry and Chemical Engineering, Nanjing University of Technology, Nanjing 210009, China*

*Corresponding author. Tel: +86-519-86330135.

E-mail addresses: pingliu02@163.com (Ping Liu); liyxluck@163.com (Yong-Xin Li).

Table S1 The specifications of supported Pd catalysts.

Catalyst	N source	The concentration of N source in aqueous solution ($\times 10^{-2}$ mol·L^{-1})	N element inputting amount (mmol)	Pd loading [a] (wt.%)
Pd/rGO				0.58
Pd/NG-EDA-3.7	ethylenediamine	4.6	3.7	0.52
Pd/NG-AW-1.5	ammonia	3.8	1.5	0.53
Pd/NG-AW-2.2	ammonia	5.5	2.2	0.54
Pd/NG-AW-3.0	ammonia	7.5	3.0	0.47
Pd/NG-AW-3.7	ammonia	9.3	3.7	0.49
Pd/NG-Urea-2.2	urea	2.8	2.2	0.53
Pd/NG-Urea-3.7	urea	4.6	3.7	0.45
Pd/NG-Urea-5.2	urea	6.5	5.2	0.47

[a] The Pd loading was determined using a VISTA.MPX inductively coupled plasma (ICP) spectroscope.

Table S2 Chemical composition of GO and various N-doped graphenes obtained by the elemental analysis.

Sample	C (at%)	O (at%)	N (at%)
GO	48.2	48.5	0.3
NG-EDA-3.7	70.9	18.2	7.7
NG-AW-2.2	68.4	24.5	5.6
NG-AW-3.7	70.7	21.1	6.1
NG-Urea-3.7	63.3	29.4	5.7

Table S3 Pd dispersions for various catalysts

Catalyst	Pd dispersion (%)
Pd/rGO	12.1
Pd/NG-EDA-3.7	64.5
Pd/NG-AW-3.7	81.3
Pd/NG-Urea-3.7	90.1

Table S4 Chemical composition of various N-doped graphenes obtained by XPS analysis.

Sample	C/O/N (at%)	Pyridinic N (at%)	Amine moieties (at%)	Pyrrolic N (at%)	Graphitic N (at%)
NG-AW-1.5	71.3/24.5/3.2	1.0	0.6	0.8	0.8
NG-AW-3.0	74.2/19.3/4.7	1.2	1.1	1.1	1.3
NG-Urea-2.2	68.1/26.8/3.7	1.1	0.7	1.0	0.9
NG-Urea-5.2	73.7/20.0/5.1	1.5	1.4	1.4	0.8

Table S5 Comparison of catalytic activities of Pd/NG-Urea-3.7 with the commerial Pd/C in the hydrogenation of cyclohexene.

Catalyst	Conversion (%)	Selectivity (%)	TOF $(mol \cdot (mol_{Pd} \cdot h)^{-1})$
Pd/C [a]	26.3	100	11035
Pd/NG-Urea-3.7	58.9	100	27463

Reaction conditions: 0.01g catalyst, 2 mL cyclohexene, 10 mL ethanol, 30 °C, 1 MPa H_2 pressure, 1 h.

[a] Purchased from Changzhou mesoporous catalytic materials Ltd, Pd loading: 0.5 wt.%.
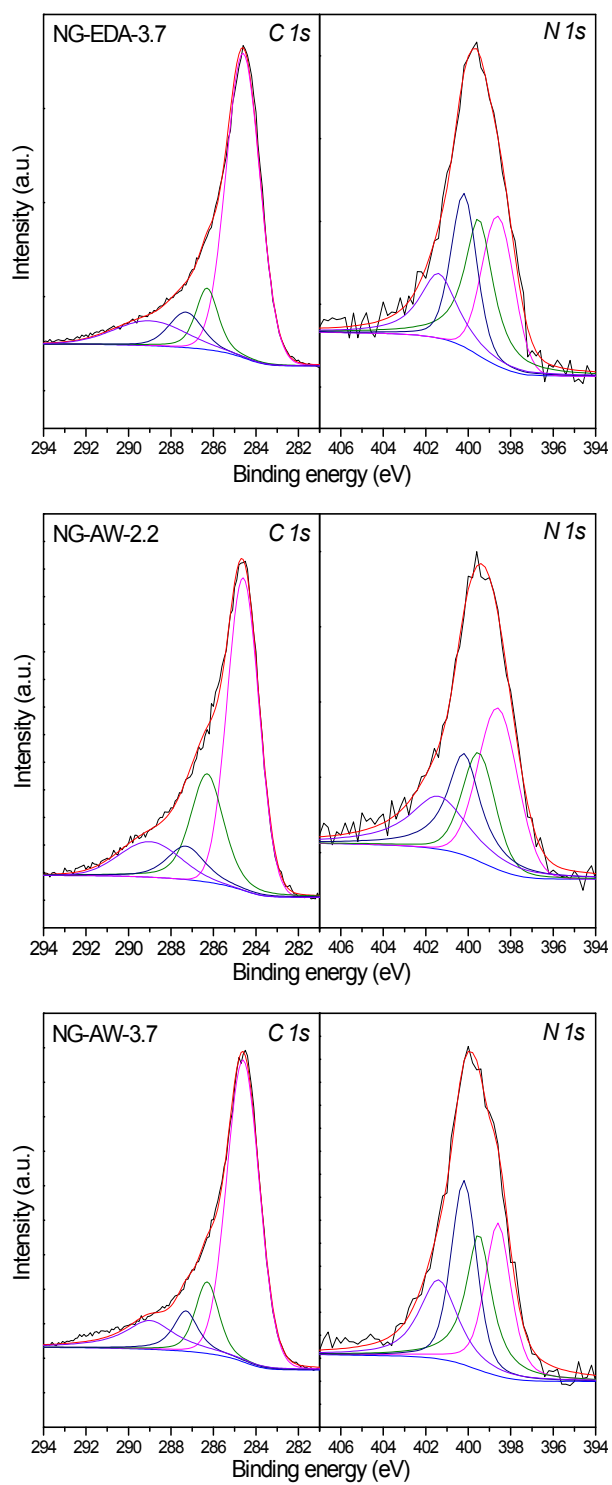
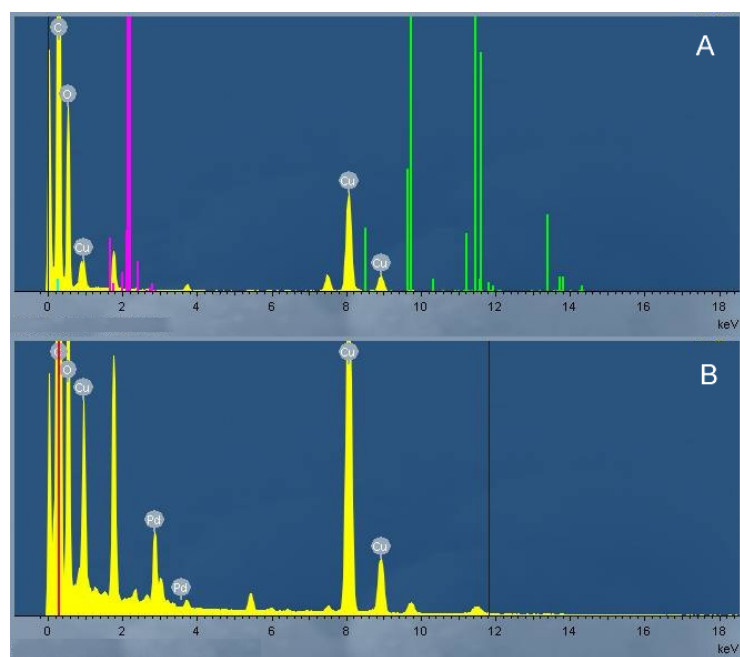**Fig. S1** XPS spectra of C and N 1s for NG-EDA-3.7, NG-AW-2.2, and NG-AW-3.7.

Fig. S2 EDS spectra of NG-Urea-3.7 (A) and Pd/NG-Urea-3.7 (B).