Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supplementary Materials

$Pt_xNi_{10-x}O$ Nanoparticles Supported on N-doped Graphene Oxides with A Synergetic Effect for Highly Efficient Hydrolysis of Ammonia Borane

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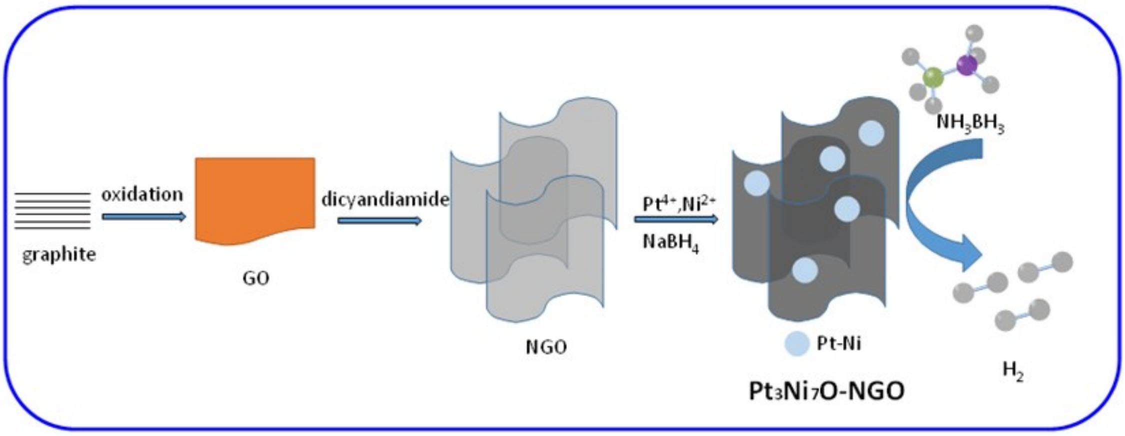

Fig. S1. Illustration of the preparation processes for the Pt_3Ni_7O-NGO sample.

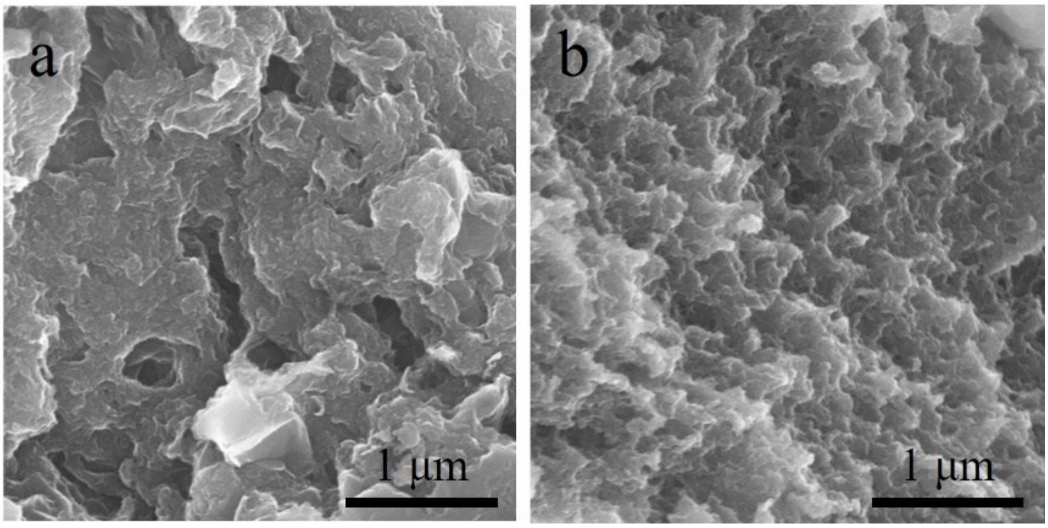

Fig. S2. SEM images of (a) pure NGO and (b) Pt_3Ni_7O-NGO.

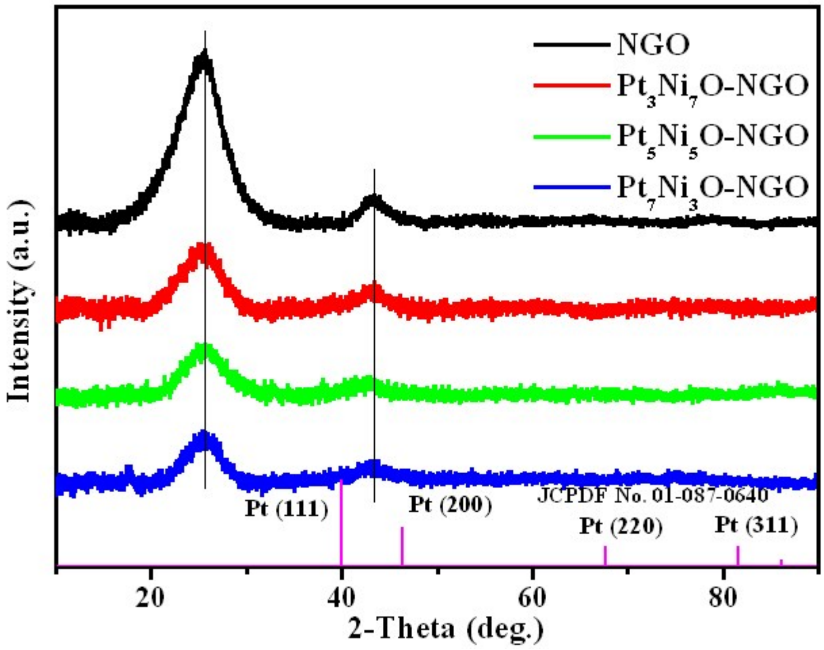

Fig. S3. XRD patterns of NGO and $Pt_xNi_{10-x}O$-NGO samples. The two broad diffraction peaks are attributed to NGO substrate. No obvious XRD peak can be observed for the $Pt_xNi_{10-x}O$ NPs.

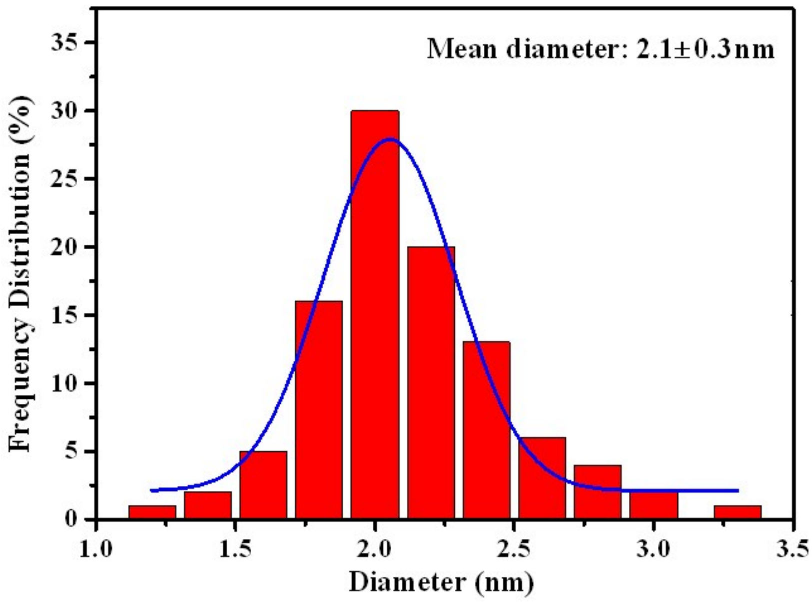

Fig. S4. The particle size distribution of Pt_3Ni_7O-NGO with an average size of 2.1 nm.

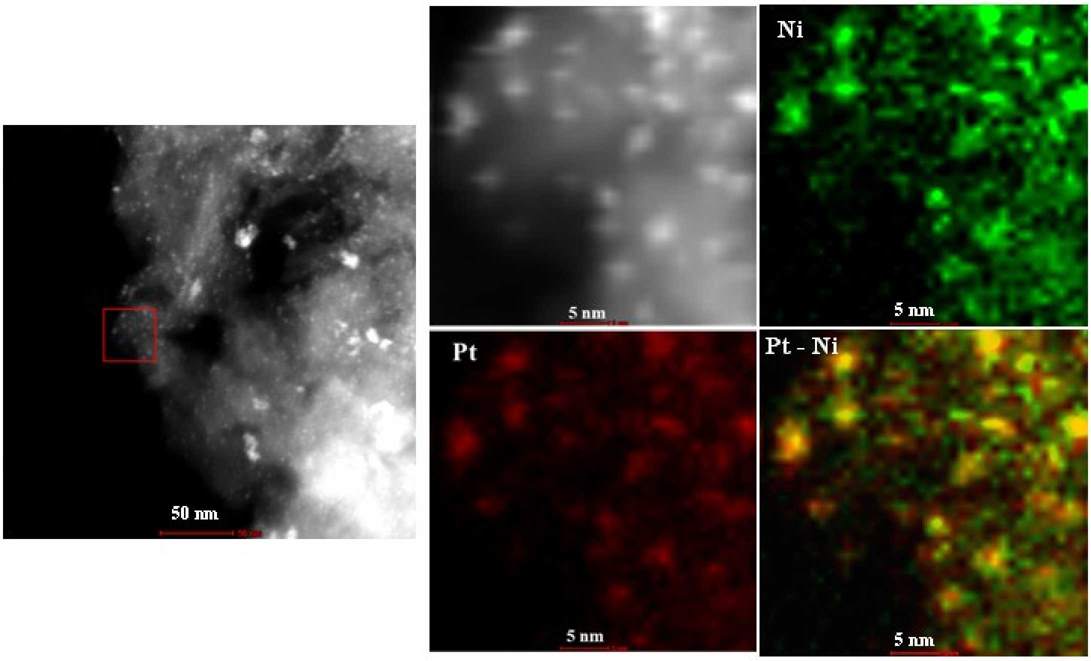

Fig. S5. Dark field TEM image and the high-resolution elemental mappings of Pt_3Ni_7O-NGO.

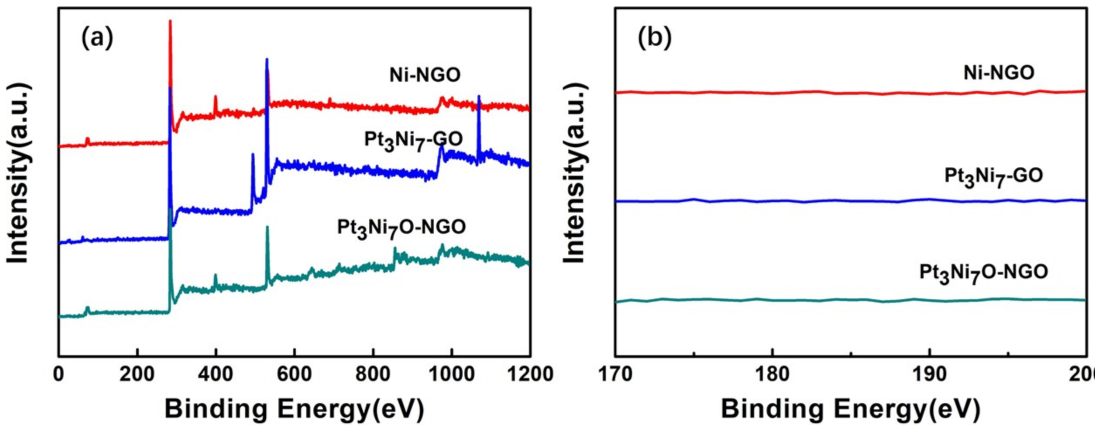

Fig. S6. XPS spectra of Pt_3Ni_7O-NGO, Pt_3Ni_7-GO and Ni-NGO: (a) the survey spectra, (b) the high-resolution spectra at B 1s edge.

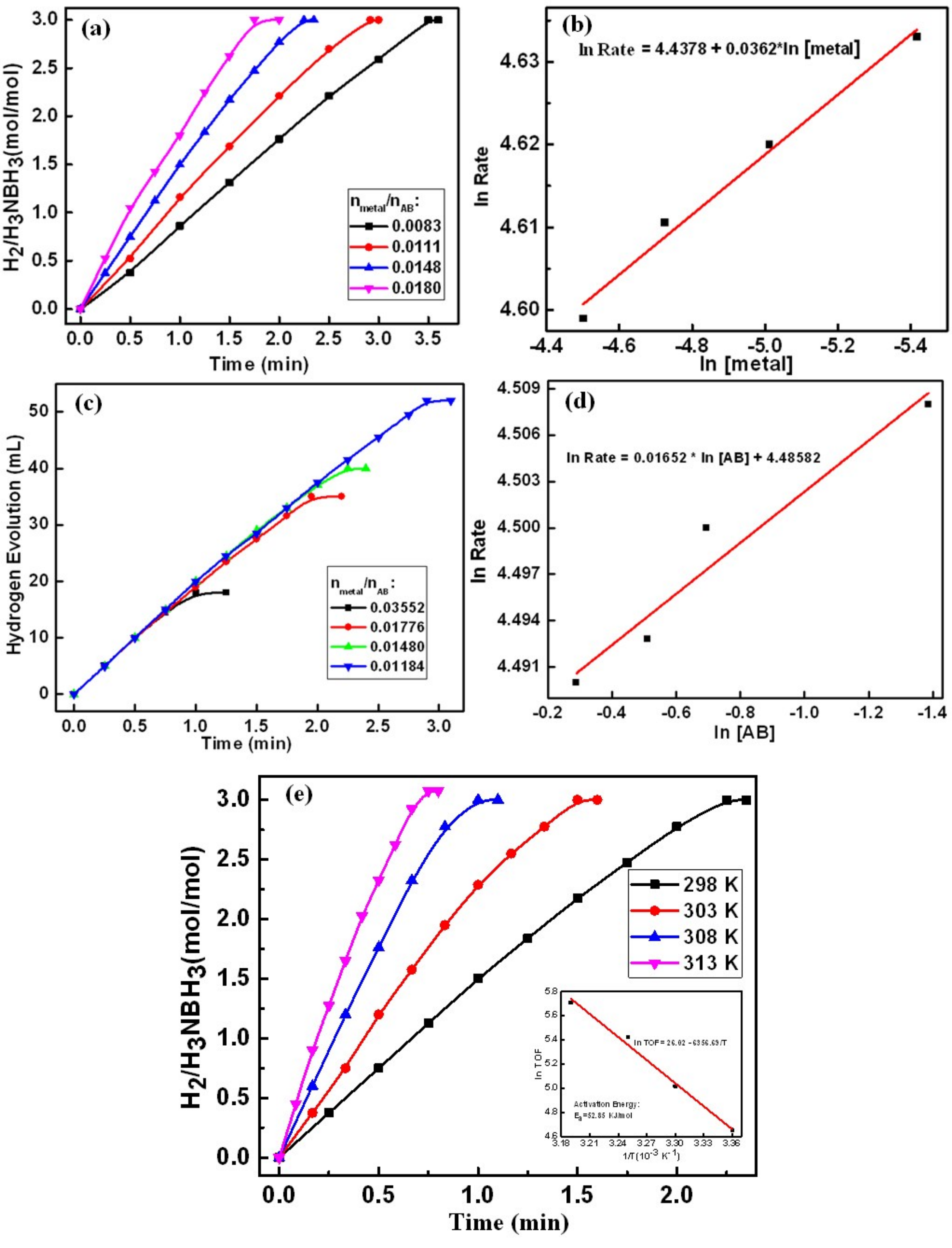

Fig. S7. (a) Stoichiometric hydrogen evolution in aqueous solution at a fixed amount of AB with various Pt_3Ni_7O-NGO/AB molar ratios at 298 K; (c) Relationship between hydrogen-generating rate and AB concentration at a fixed amount of Pt_3Ni_7O-NGO in aqueous solution at 298 K; (b) and (d): Logarithmic plots of rate versus [Pt_3Ni_7O-NGO] and [AB], respectively. (e) Hydrogen-generating rate as a function of temperature in the hydrolysis of AB catalyzed by Pt_3Ni_7O-NGO. Inset: Arrhenius plot of ln(TOF) versus 1/*T*. The activation energy is calculated to be 52.85 kJ/mol.

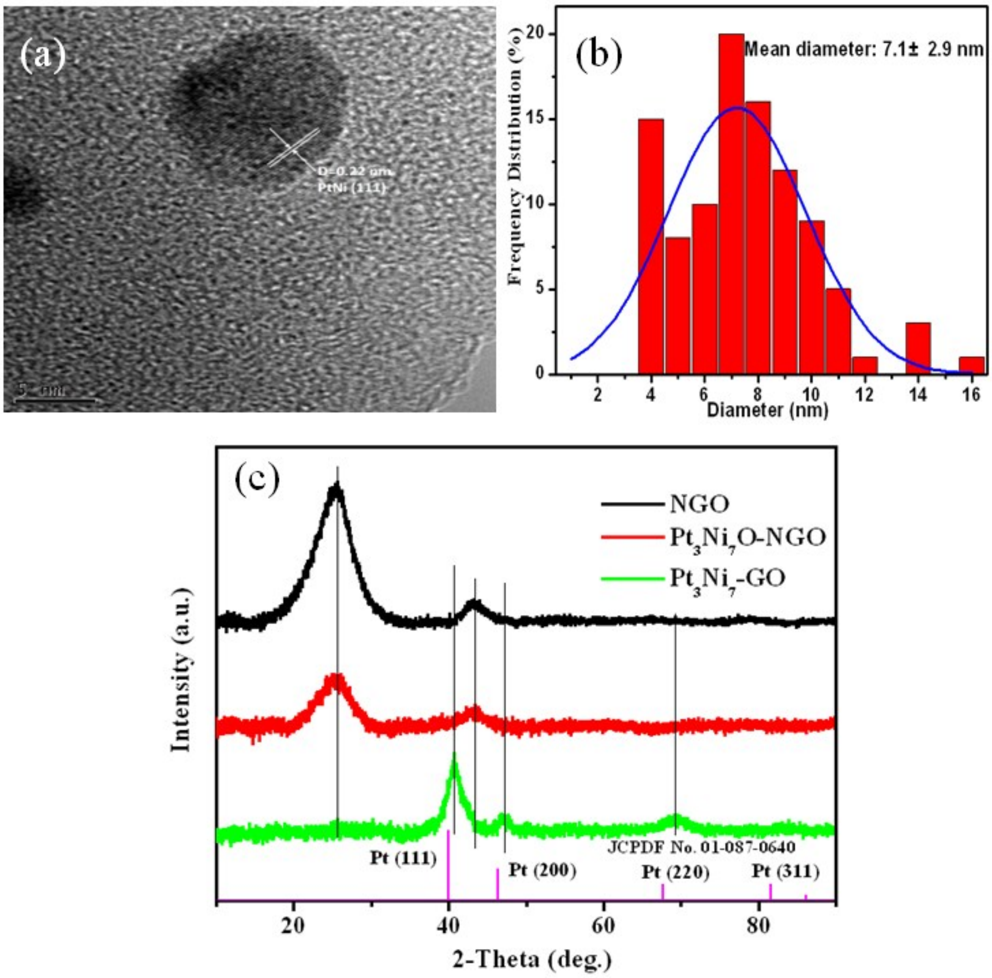

Fig. S8. TEM image (a), particle size distribution (b) and XRD pattern of Pt_3Ni_7-GO. The XRD patterns of NGO, Pt_3Ni_7O-NGO and the standard Pt are shown for comparison.

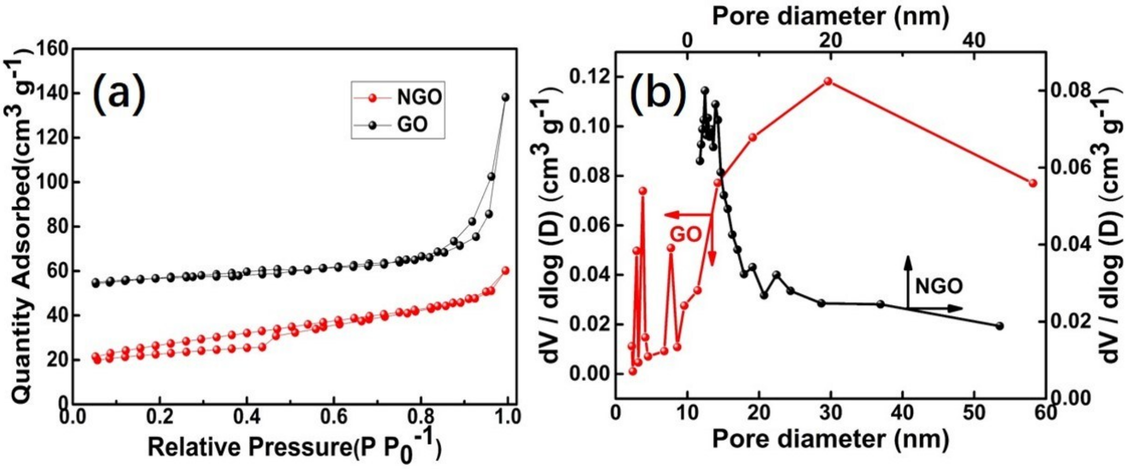

Fig. S9. (a) N_2 adsorption-desorption isotherms of NGO and GO at 77 K. (b) The corresponding pore size distributions of NGO and GO.

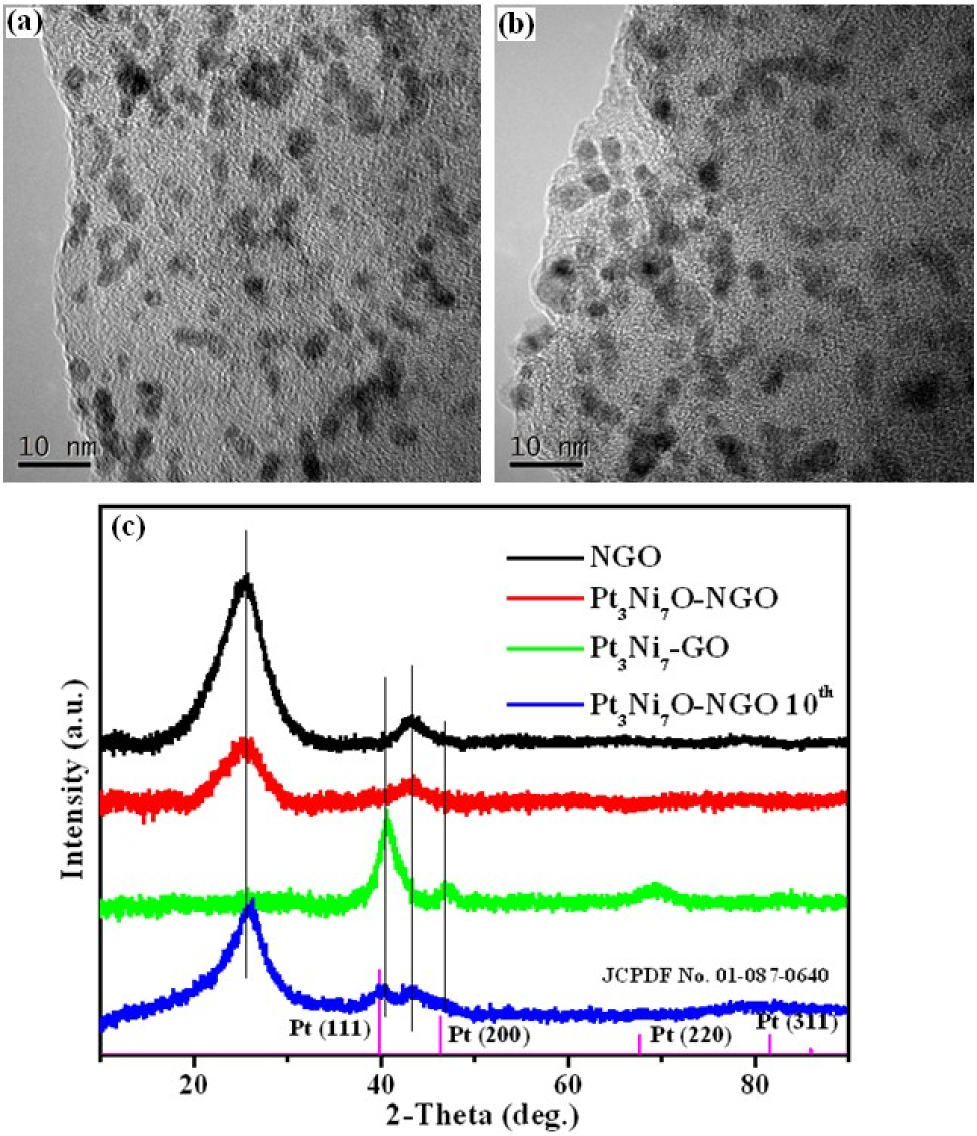

Fig. S10. (a) and (b): TEM images of the as-prepared Pt_3Ni_7O-NGO and Pt_3Ni_7O-NGO after 9 cycles (labeled as Pt_3Ni_7O-NGO 10^{th}), respectively. (c) XRD patterns of NGO, Pt_3Ni_7O-NGO, Pt_3Ni_7-GO and Pt_3Ni_7O-NGO 10^{th}.

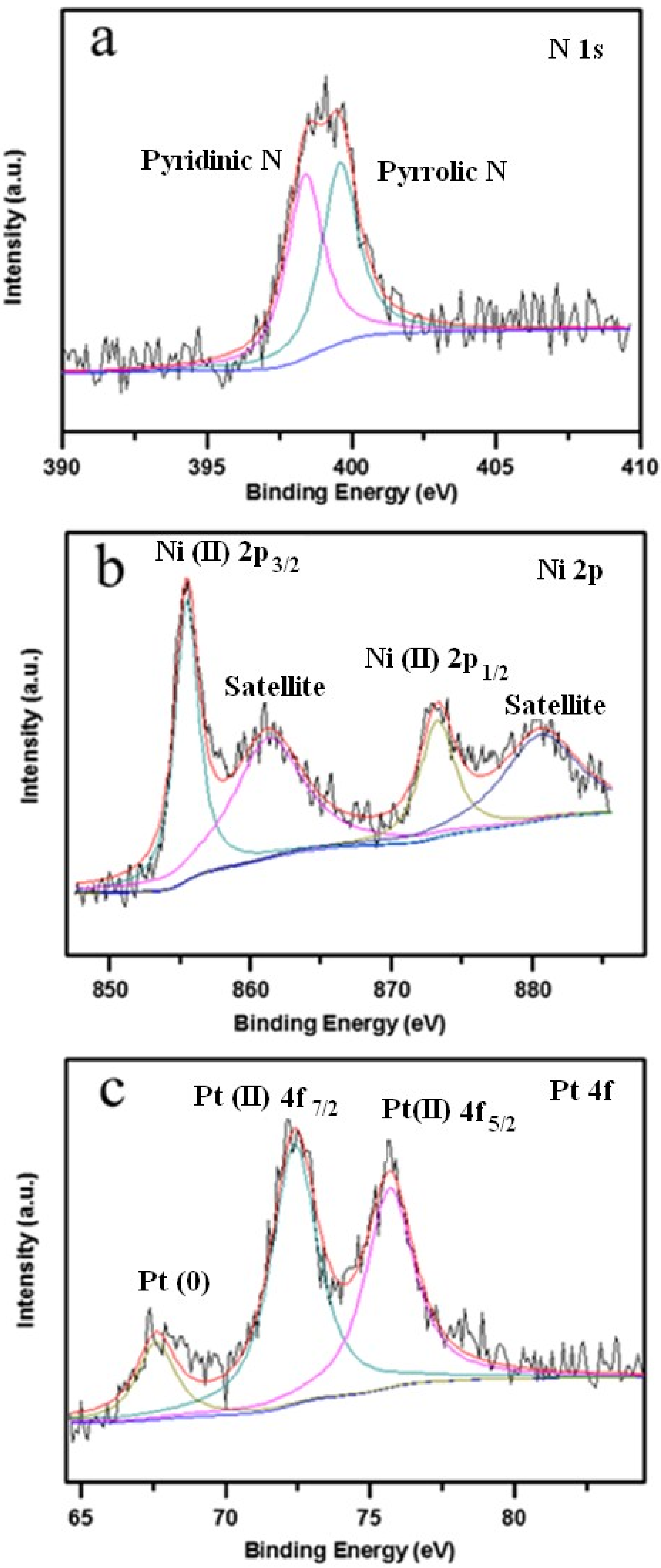

Fig. S11. XPS spectra of Pt_3Ni_7O-NGO at (a) N 1s, (b) Ni 2p, and (c) Pt 4f edges, respectively.

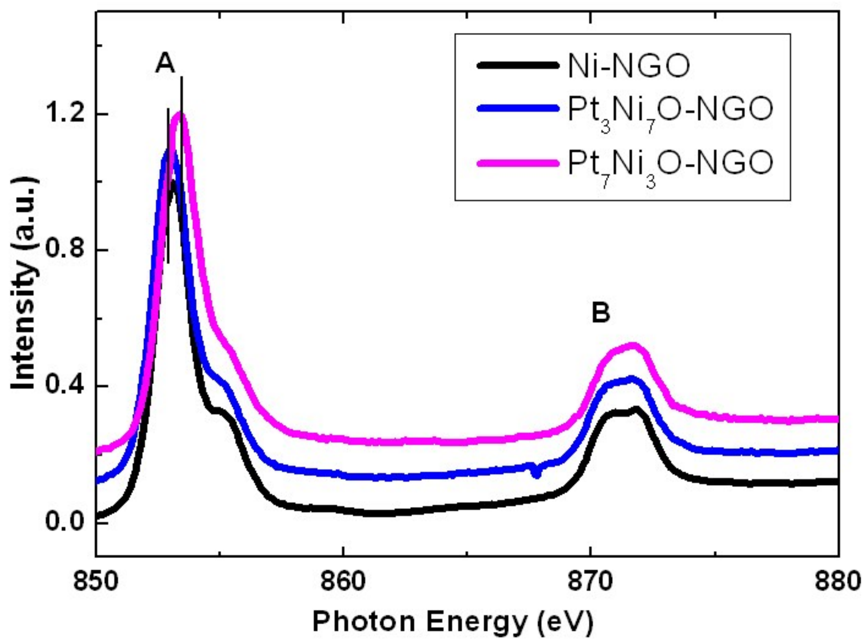

Fig. S12. Soft X-ray XAS spectra of Ni-NGO, Pt_3Ni_7O-NGO and Pt_7Ni_3O-NGO at Ni *L*-edge.

Samples	Pt-loading (wt%)	Ni-loading (wt%)	The atomic ratio of Pt and Ni	TOF (H_2) mol/(Cat-M)mol·min	TOF (H_2) mol/(Cat-Pt)mol·min
Pt_3Ni_7O-NGO	**4.92**	**7.21**	**2:10**	**120.7**	**709.6**
Pt_5Ni_5O-NGO	9.14	4.49	6.1:10	67.1	176.9
Pt_7Ni_3O-NGO	10.12	6.41	4.7:10	42.5	132.0
Pt_3Ni_7-GO	1.16	1.39	2.5:10	68.2	339.2
Ni-NGO	-	17.82	-	1.3	-
Pt-NGO	13.50	-	-	104.2	104.2
NGO	-	-	-	0	0

Table S1. Pt and Ni contents (measured by ICP-OES) and the TOF values of various $Pt_xNi_{10-x}O$-NGO, Pt_3Ni_7-GO, Ni-NGO, Pt-NGO and NGO samples.

Catalyst	TOF (H_2) mol/(Cat-Pt)mol·min	T (°C)	Ref.
PtNi/NiO	1240.3	25	1
Pt_3Ni_7O-NGO	709.6	25	This work
Pt_4Ni_1@PVP NPs	638	25	2
Pt/CNTs-O-HT	468	25	3
Pt@MIL-101	414	25	4
PEI-GO/$Pt_{0.17}Co_{0.83}$	377.83	25	5
Pt-TiO_2	311	25	6
G4-OH($Pt_{12}Ni_{48}$)	239.7	70	7
Pt/γ-Al_2O_3	222.22	25	8
Pt/C	111	25	9
PtO_2	20.8	25	9
Pt black	13.9	25	9

Table S2. Comparison of the TOF value of Pt-based catalysts for the hydrolysis of amine boranes in this work and those reported in the literatures.

References listed in Table S2:

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Cycles	**TOF** **(H_2) mol/(Cat-Pt)mol·min**	**Catalytic Efficiency**
1st	709.6	100%
2nd	681.2	96.0%
3rd	627.8	88.5%
4th	627.8	88.5%
5th	584.7	82.4%
6th	584.7	82.4%
7th	544.9	76.8%
8th	544.9	76.8%
9th	544.9	76.8%
10th	544.9	76.8%

Table S3. TOF values and the catalytic efficiencies of Pt_3Ni_7O-NGO in different cycles during the stability test.