Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Porous nitrogen-doped carbon-immobilized bimetallic nanoparticles as highly efficient catalysts for hydrogen generation from hydrolysis of ammonia borane

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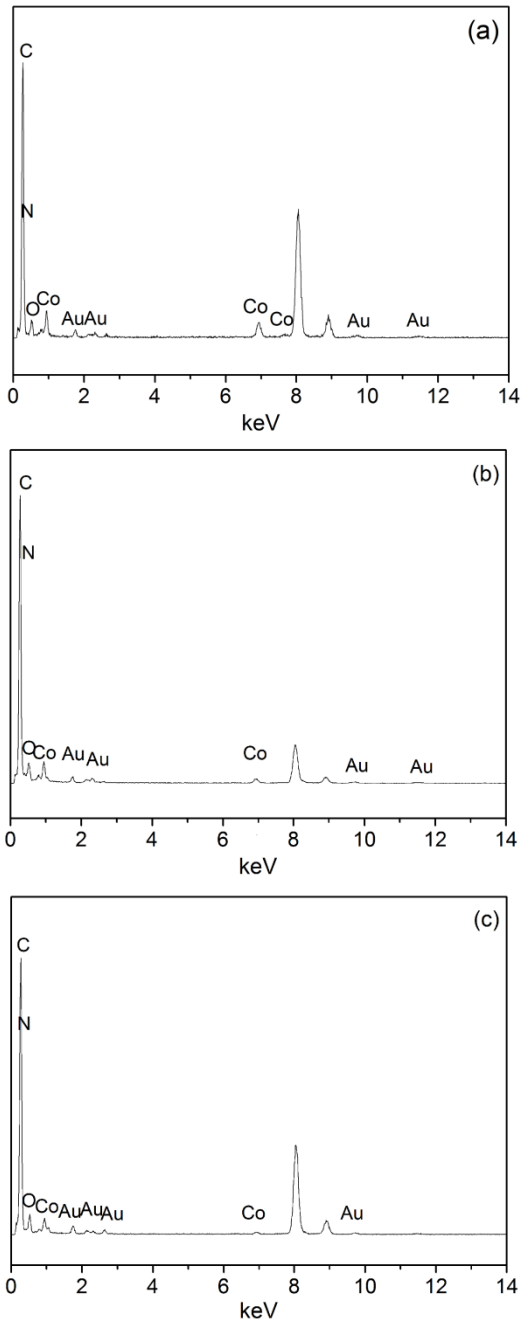

Fig. S1 EDS of (a) AuCo/NXC-1, (b) AuCo/NXC-2 and (c) AuCo/NXC-3 (Au/Co = 1/7).

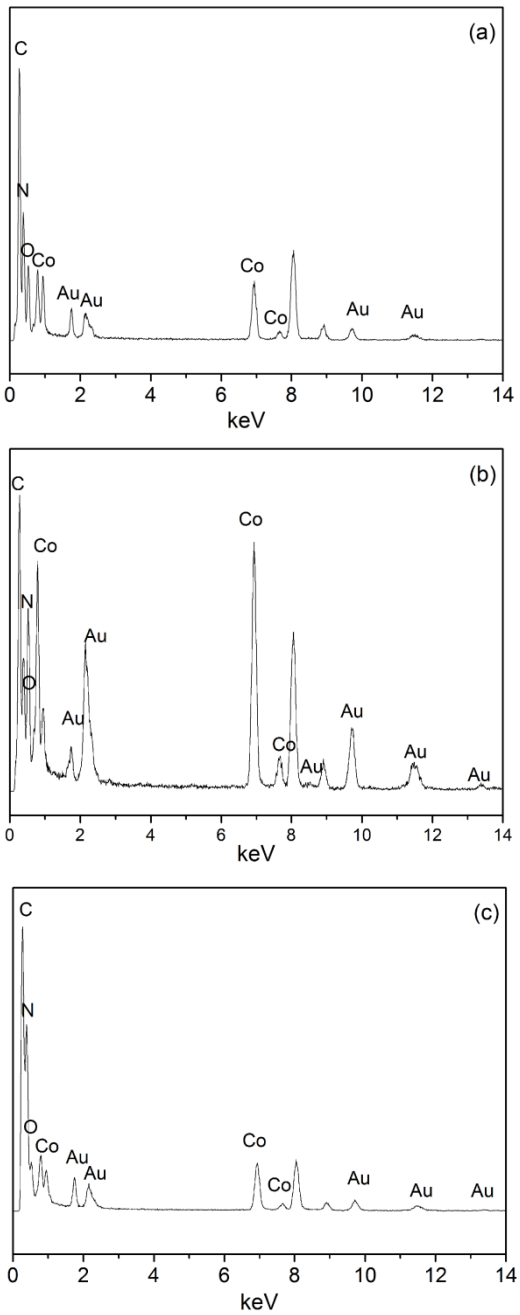

Fig. S2 EDS of (a) AuCo/C_3N_4-1, (b) AuCo/C_3N_4-2 and (c) AuCo/C_3N_4-3 (Au/Co = 1/7).

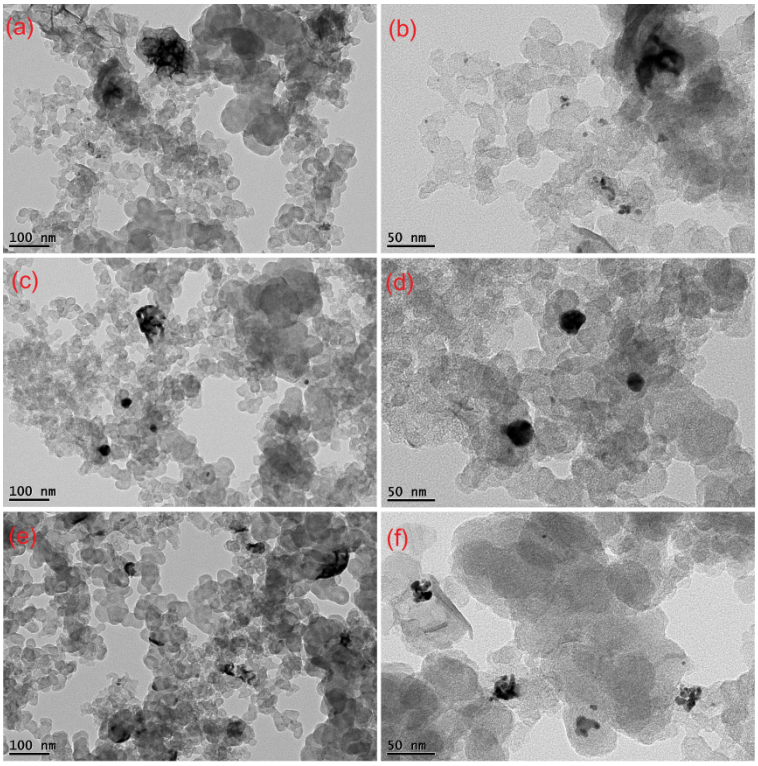

Fig. S3 Representative TEM images of (a, b) AuCo/XC-1, (c, d) AuCo/XC-2 and (e, f) AuCo/XC-3 (Au/Co = 1/7).

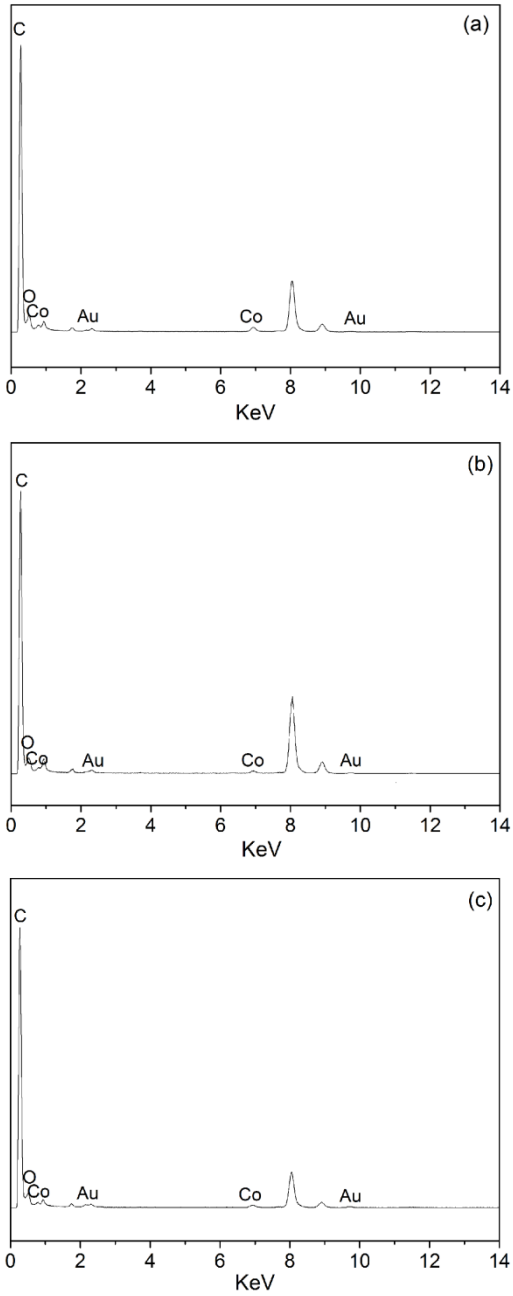

Fig. S4 EDS of (a) AuCo/XC-1, (b) AuCo/XC-2 and (c) AuCo/XC-3 (Au/Co = 1/7).

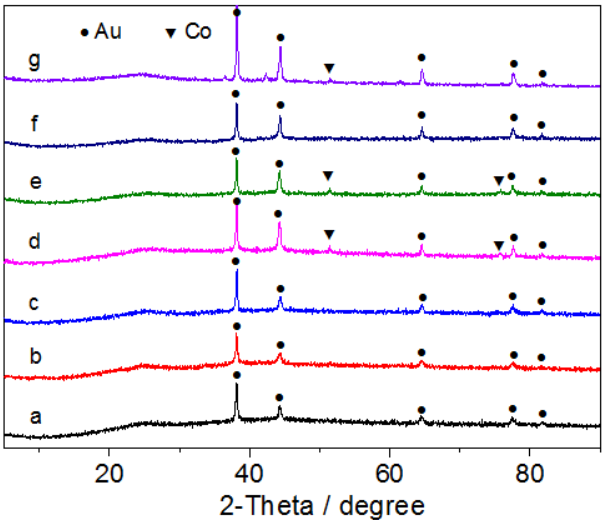

Fig. S5 XRD patterns of (a) AuCo/NXC-1, (b) AuCo/NXC-2 and (c) AuCo/NXC-3; (d) AuCo/NXC-1, (e) AuCo/NXC-2 and (f) AuCo/NXC-3 after heat treatment at 873 K for 4 h in Ar atmosphere; (g) AuCo/NXC-3 after heat treatment at 1173 K for 4 h in Ar atmosphere.

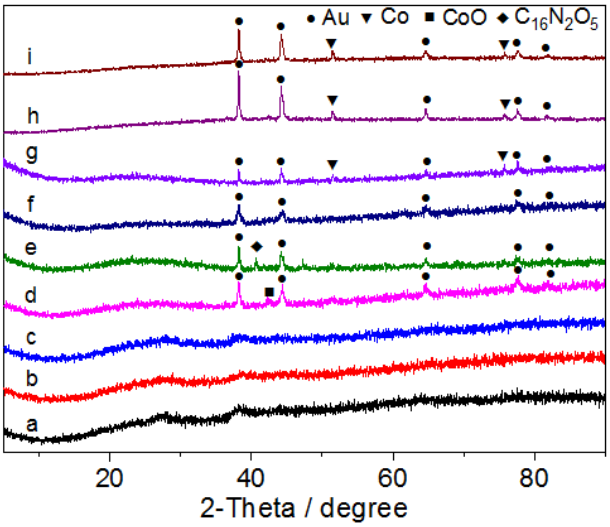

Fig. S6 XRD patterns of (a) AuCo/C_3N_4-1, (b) AuCo/C_3N_4-2 and (c) AuCo/C_3N_4-3; (d) AuCo/C_3N_4-1, (e) AuCo/C_3N_4-2 and (f) AuCo/C_3N_4-3 after heat treatment at 873 K for 4 h in Ar atmosphere; (g) AuCo/C_3N_4-1, (h) AuCo/C_3N_4-2 and (i) AuCo/C_3N_4-3 after heat treatment at 1173 K for 4 h in Ar atmosphere.

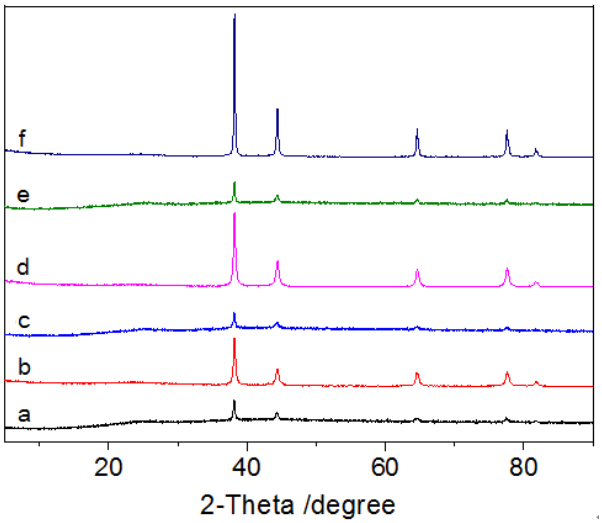

Fig. S7 XRD patterns of (a) AuCo/NXC-1, (b) Au/NXC-1, (c) AuCo/NXC-2, (d) Au/NXC-2, (e) AuCo/NXC-3 and (f) Au/NXC-3.

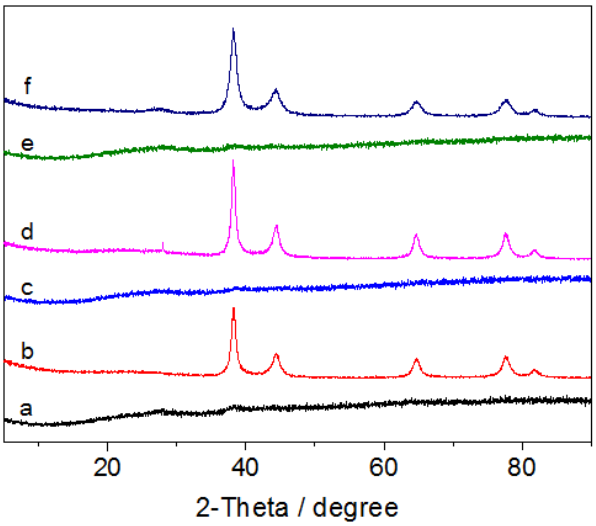

Fig. S8 XRD patterns of (a) AuCo/C_3N_4-1, (b) Au/C_3N_4-1, (c) AuCo/C_3N_4-2, (d) Au/C_3N_4-2, (e) AuCo/C_3N_4-3 and (f) Au/C_3N_4-3.

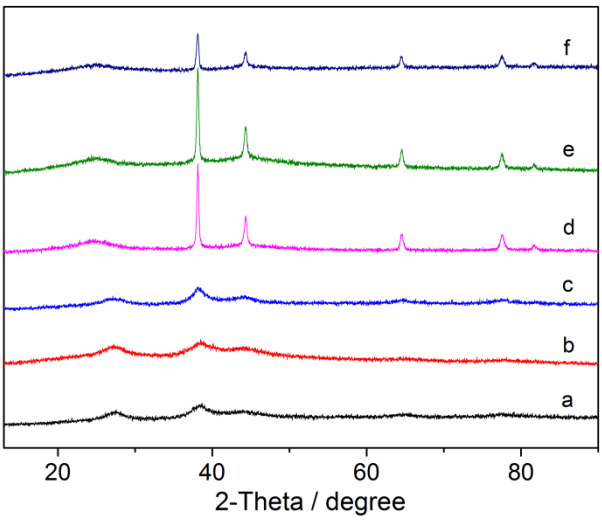

Fig. S9 XRD patterns of (a) AuNi/C_3N_4-1, (b) AuNi/C_3N_4-2, (c) AuNi/C_3N_4-3, (d) AuNi/NXC-1, (e) AuNi/NXC-2 and (f) AuNi/NXC-3.

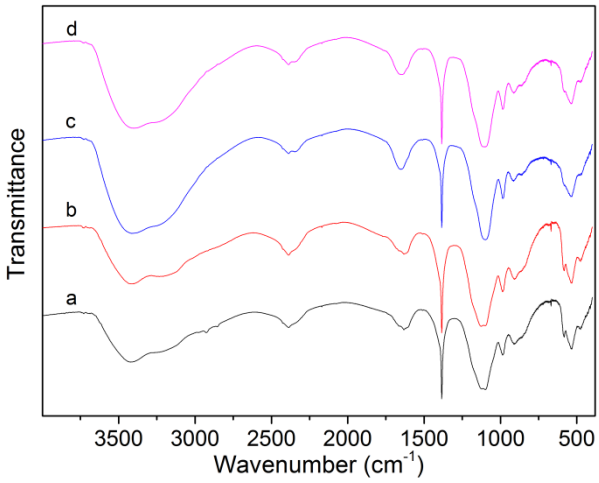

Fig. S10 IR spectra of (a) NXC, (b) AuCo/NXC-1, (c) AuCo/NXC-2 and (d) AuCo/NXC-3.

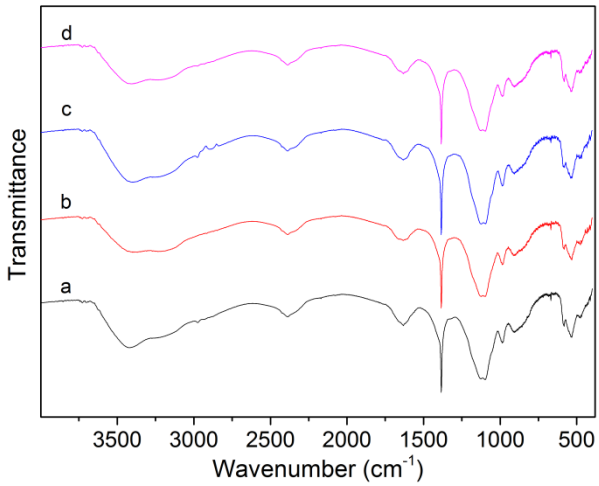

Fig. S11 IR spectra of (a) C_3N_4, (b) AuCo/C_3N_4-1, (c) AuCo/C_3N_4-2 and (d) AuCo/C_3N_4-3.

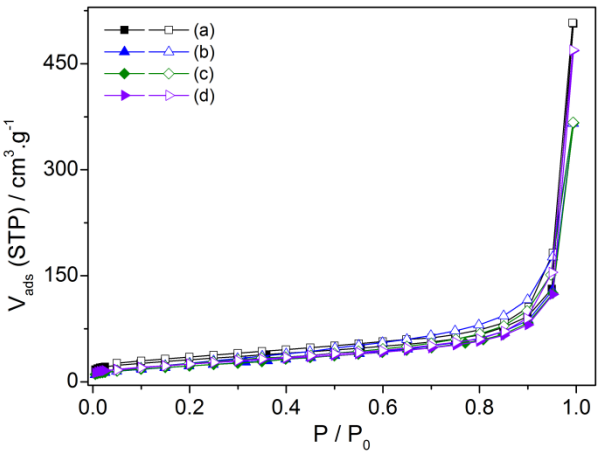

Fig. S12 N_2 sorption isotherms of (a) NXC, (b) AuCo/NXC-1, (c) AuCo/NXC-2 and (d) AuCo/NXC-3 (Au/Co = 1/7) at 77 K.

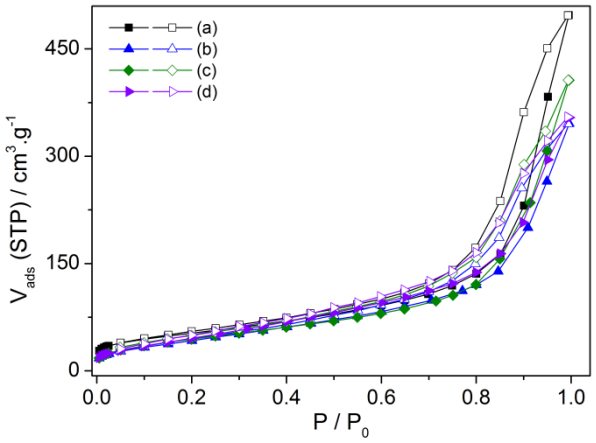

Fig. S13 N_2 sorption isotherms of (a) C_3N_4, (b) AuCo/C_3N_4-1, (c) AuCo/C_3N_4-2 and (d) AuCo/C_3N_4-3 (Au/Co = 1/7) at 77 K.

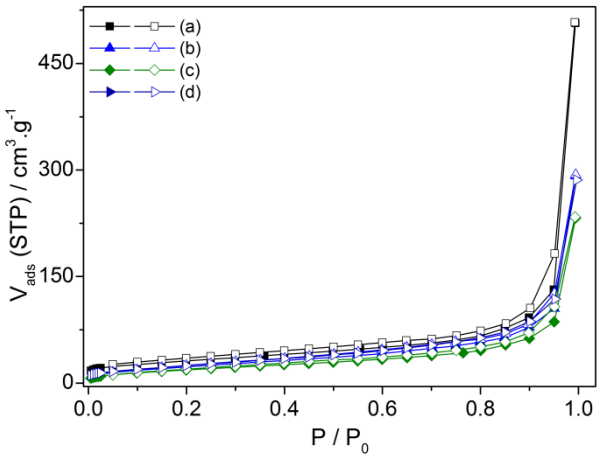

Fig. S14 N_2 sorption isotherms of (a) NXC, (b) AuNi/NXC-1, (c) AuNi/NXC-2 and (d) AuNi/NXC-3 (Au/Co = 1/7) at 77 K.

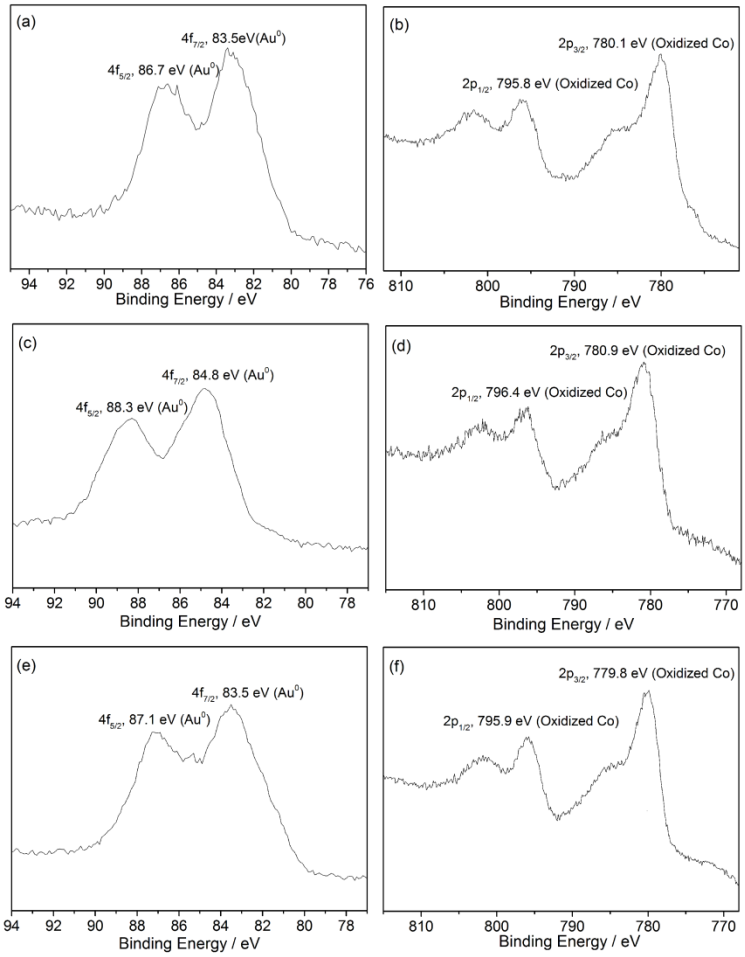

Fig. S15 XPS spectra for (a, b) AuCo/C_3N_4-1, (c, d) AuCo/C_3N_4-2 and (e, f) AuCo/C_3N_4-3 (Au/Co = 1/7).

Table S1 TOF and E_a values for hydrolysis of AB catalysed by different catalysts at 298 K.

Catalyst	TOF ($mol_{H2}\cdot mol_{cat}^{-1}\cdot min^{-1}$)	Ref.
AuCo/NXC-1	42.1	This work
AuCo/NXC-2	7.2	This work
AuCo/NXC-3	12.6	This work
AuCo/C_3N_4-1	30.6	This work
AuCo/C_3N_4-2	6.4	This work
AuCo/C_3N_4-3	14.7	This work
AuCo/XC-1	31.6	This work
AuCo/XC-2	1.6	This work
AuCo/XC-3	7.2	This work
Au-Co@CN with light	48.28	10
Au-Co@CN	28.4	10
Pd@Co/graphene	40.9	9(d)
Ru@Co/graphene	40.46	7(o)
Co/PEI-GO	39.9	19(d)
In situ Co	39.8	19(a)
Co(0) nanoclusters	25.7	22(a)
AuCo@MIL-101	23.5	20
CuCo@MIL-101	19.6	9(e)
Cu@Co	15	7(h)
Au@Co	13.7	7(d)
Cu@FeCo	10.5	22(b)
Ag@Co/graphene	10.23	19(c)
Co/hydroxyapatite	4.54	24(b)
Co/Al_2O_3	2.08	24(a)

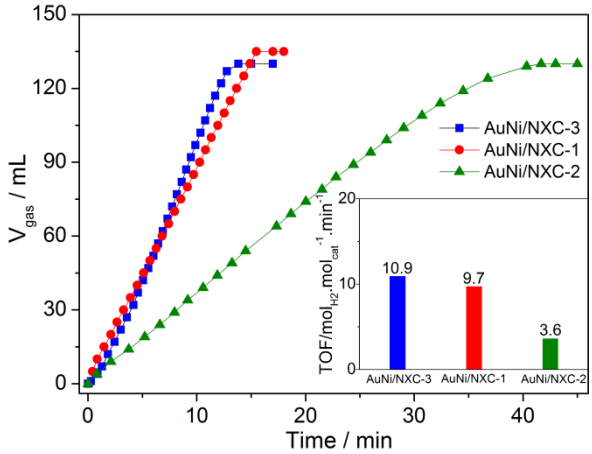

Fig. S16 Plots of time versus volume of H_2 generated from aqueous NH_3BH_3 (0.276 M, 6.2 mL) over AuNi/NXC-3, AuNi/NXC-1 and AuNi/NXC-2 at room temperature.

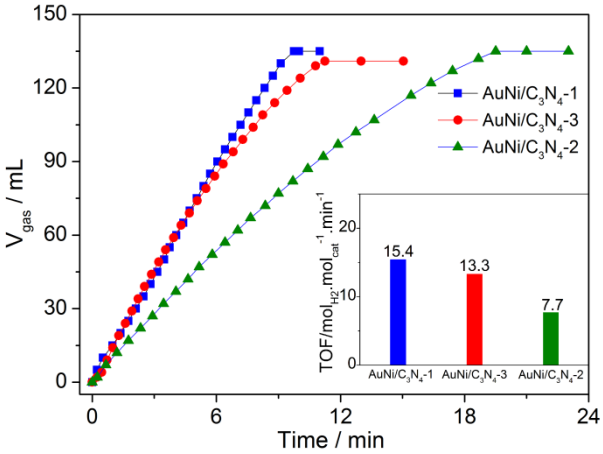

Fig. S17 Plots of time versus volume of H_2 generated from aqueous NH_3BH_3 (0.276 M, 6.2 mL) over AuNi/C_3N_4-1, AuNi/C_3N_4-3 and AuNi/C_3N_4-2 at room temperature.

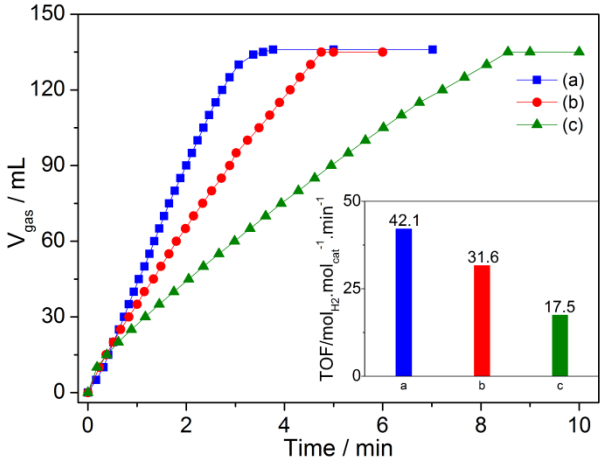

Fig. S18 Plots of time versus volume of H_2 generated from aqueous NH_3BH_3 (0.276 M, 6.2 mL) over AuCo/NXC-1 with different mole ratio of Au/Co: (a) 1:7; (b) 1:3; (c) 1:1.

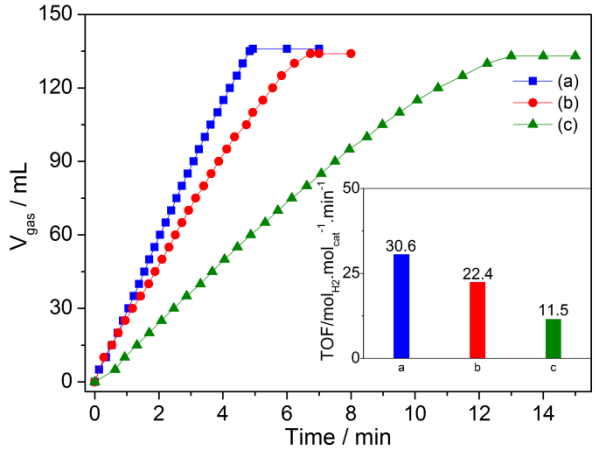

Fig. S19 Plots of time versus volume of H_2 generated from aqueous NH_3BH_3 (0.276 M, 6.2 mL) over AuCo/C_3N_4-1 with different mole ratio of Au/Co: (a) 1:7; (b) 1:3; (c) 1:1.

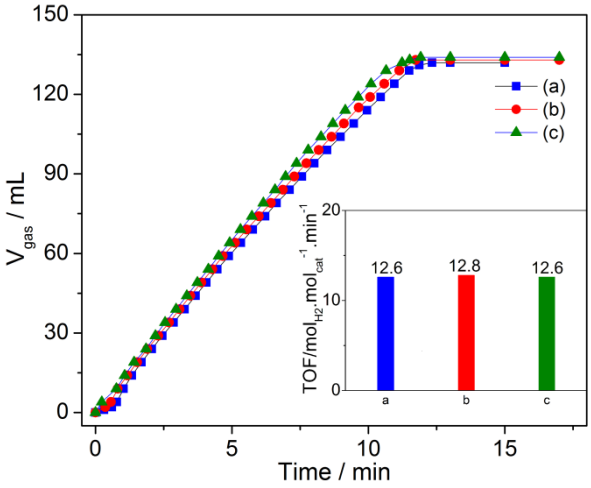

Fig. S20 plots of time versus volume of H_2 generated from aqueous NH_3BH_3 (0.276 M, 6.2 mL) over AuCo/NXC-3 with different mole ratio of Au/Co: (a) 1:7; (b) 1:3; (c) 1:1.

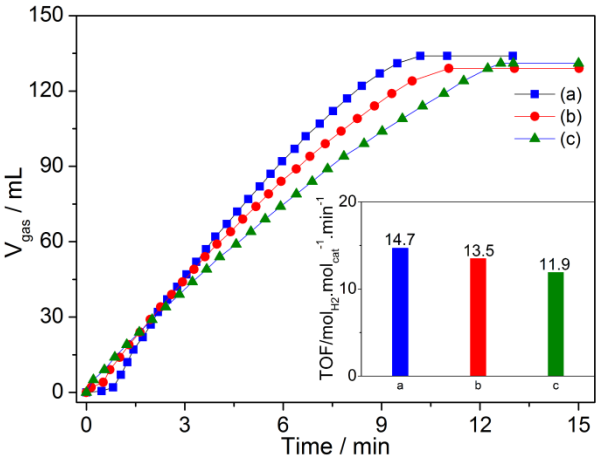

Fig. S21 plots of time versus volume of H_2 generated from aqueous NH_3BH_3 (0.276 M, 6.2 mL) over AuCo/C_3N_4-3 with different mole ratio of Au/Co: (a) 1:7; (b) 1:3; (c) 1:1.

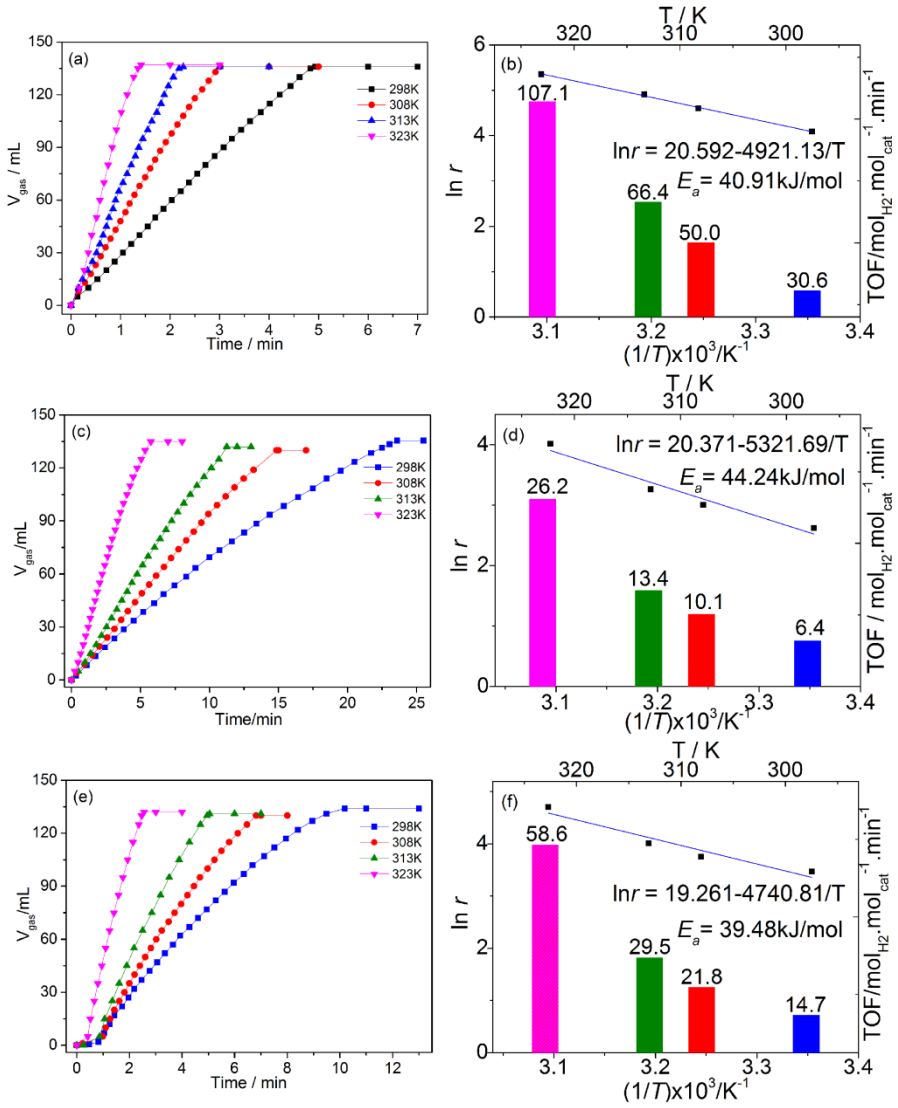

Fig. S22 Plots of time versus volume of H_2 generated from aqueous NH_3BH_3 (0.276 M, 6.2 mL) and Arrhenius plots and TOF values of NH_3BH_3 dehydrogenation over (a, b) AuCo/C_3N_4-1, (c, d) AuCo/C_3N_4-2, and (e, f) AuCo/C_3N_4-3 (Au/Co = 1/7) at different temperatures.