Electronic Supplementary Material (ESI) for RSC Advances.

Supporting information

Carbon Nitride Supported $Ni_{0.5}Co_{0.5}O$ Nanoparticles with Strong Interfacial Interaction to Enhance The Hydrolysis of Ammonia Borane

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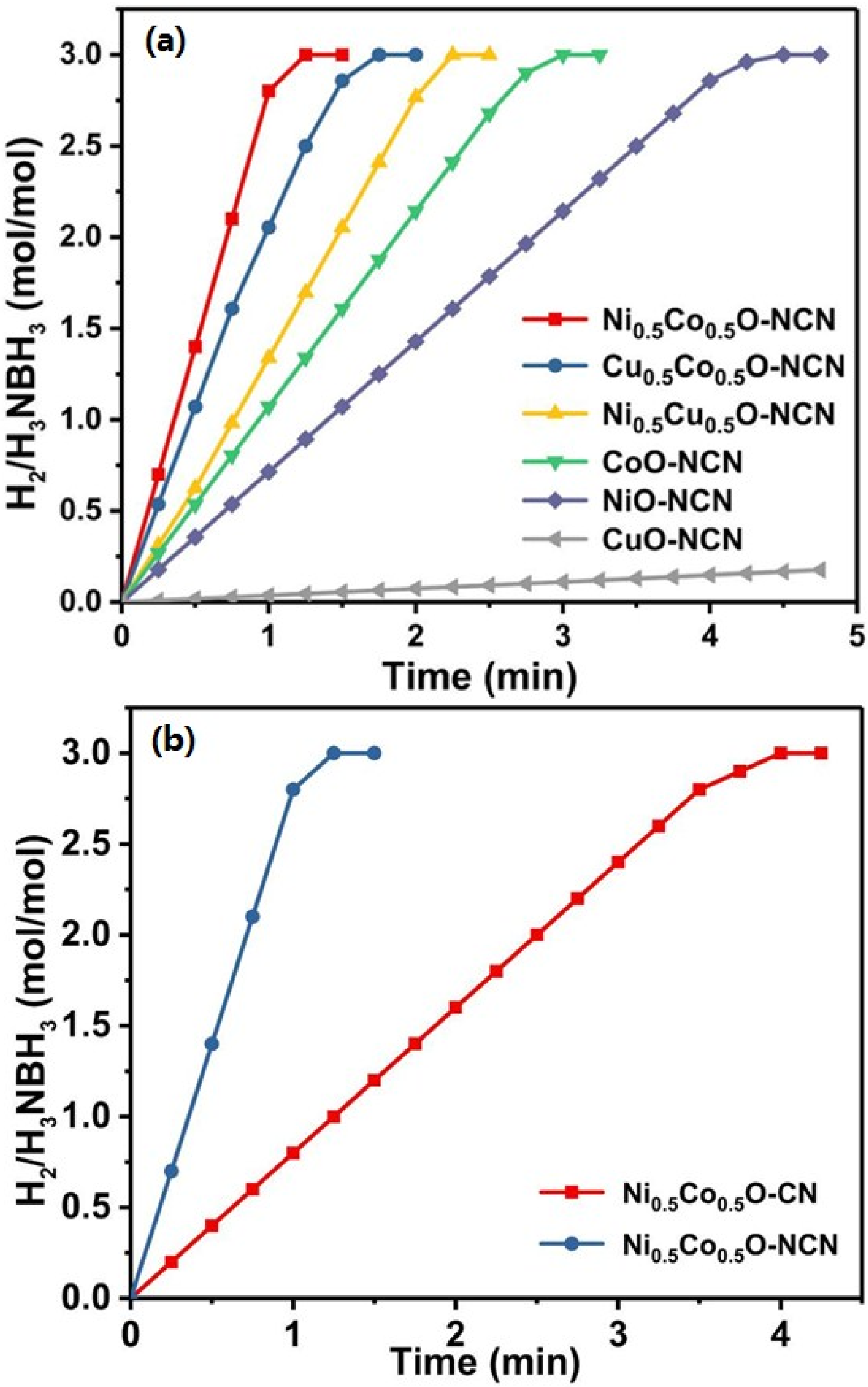

Figure S1: (a) Hydrogen evolution curves of the hydrolysis of AB aqueous solution catalyzed by $Ni_{0.5}Co_{0.5}O$-NCN, $Cu_{0.5}Co_{0.5}O$-NCN, $Ni_{0.5}Cu_{0.5}O$-NCN, CoO-NCN NiO-NCN and CuO-NCN. (b) Comparison of the hydrogen evolution curves catalyzed by $Ni_{0.5}Co_{0.5}O$-CN and $Ni_{0.5}Co_{0.5}O$-NCN.

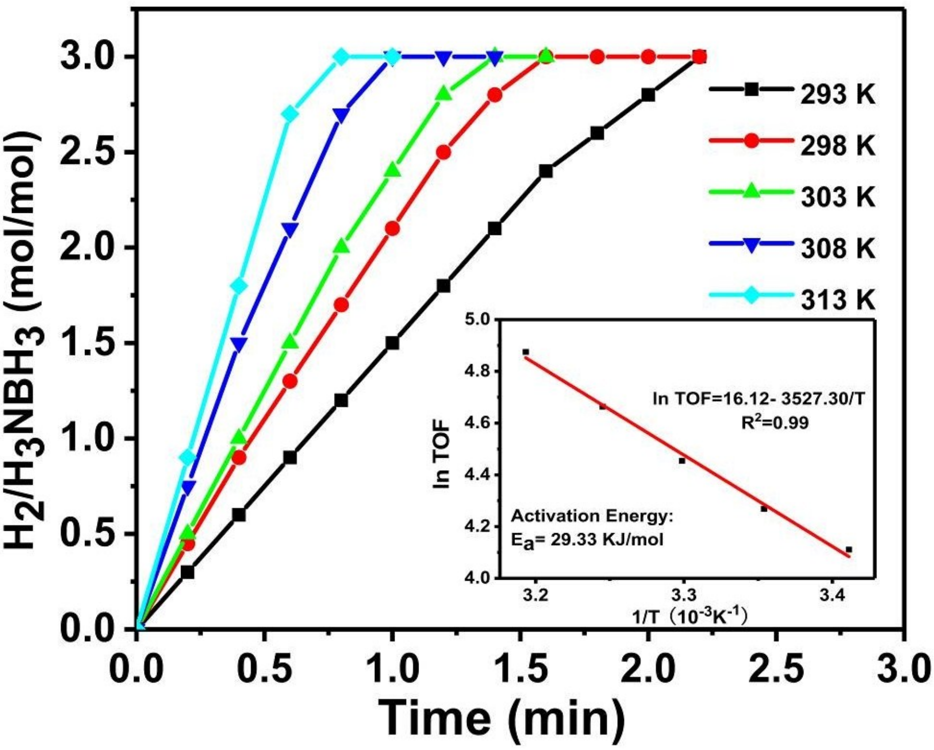

Figure S2: Hydrogen-generating rate as a function of temperature in the hydrolysis of AB catalyzed by $Ni_{0.5}Co_{0.5}O$-NCN. Since at a high temperature the reaction will be finished quickly, we have used less $Ni_{0.5}Co_{0.5}O$-NCN (2.5 mg) in this reaction. Inset: Arrhenius plot of ln(TOF) versus 1/*T*. The activation energy is 43.18 kJ/mol.

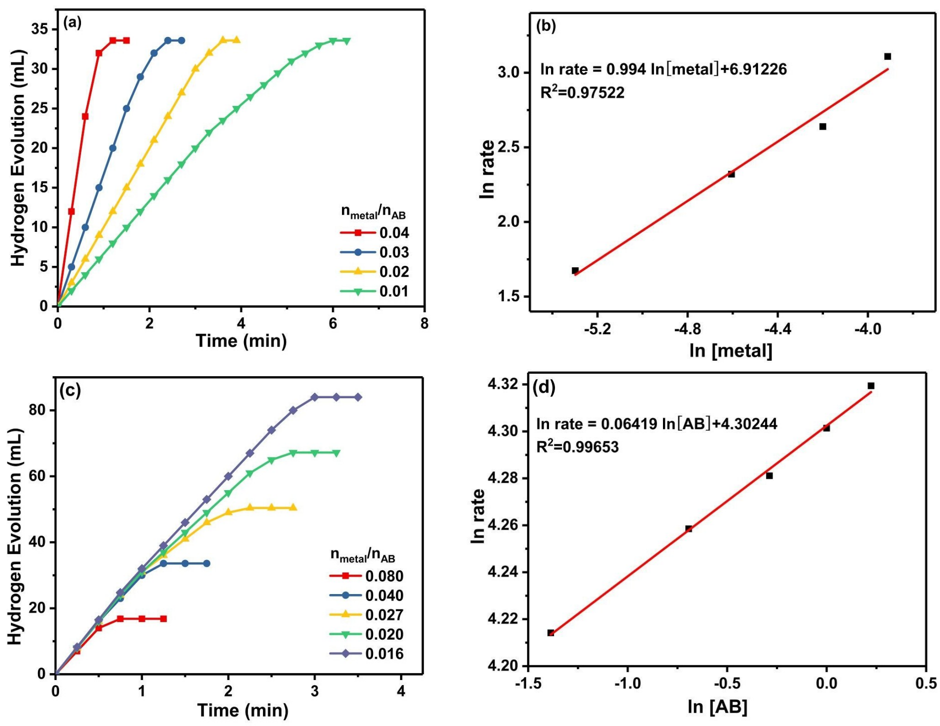

Figure S3: (a) Stoichiometric hydrogen evolution in aqueous solution at a fixed amount of AB with various $Ni_{0.5}Co_{0.5}O$-NCN/AB molar ratios at 298 K; (c) Relationship between hydrogen-generating rate and AB concentration at a fixed amount of $Ni_{0.5}Co_{0.5}O$-NCN in aqueous solution at 298 K; (b) and (d): Logarithmic plots of rate versus [$Ni_{0.5}Co_{0.5}O$-NCN] and [AB], respectively.

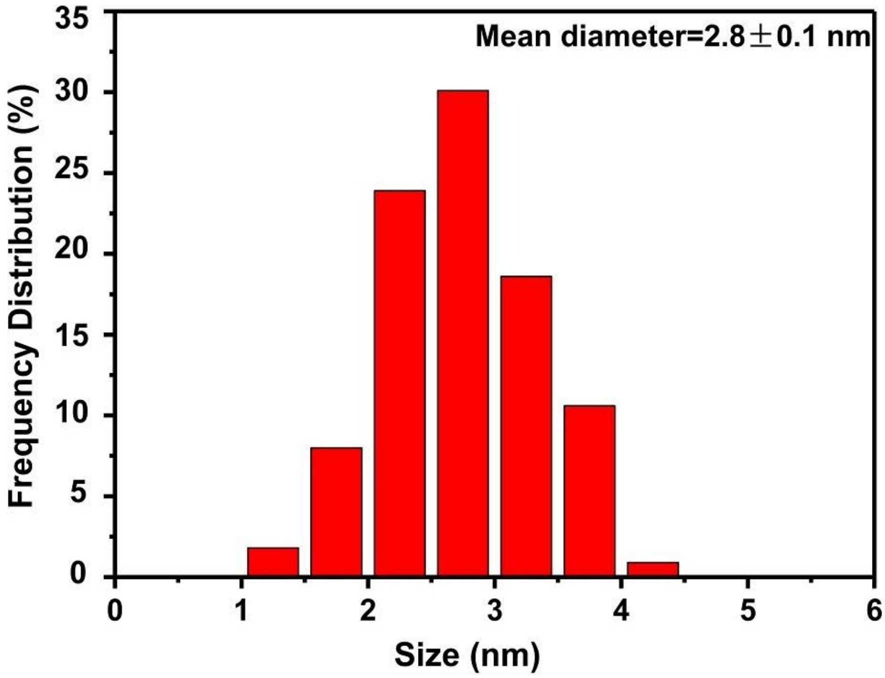

Figure S4: The particle size distribution of $Ni_{0.5}Co_{0.5}O$-NCN with an average size of 2.8 nm.

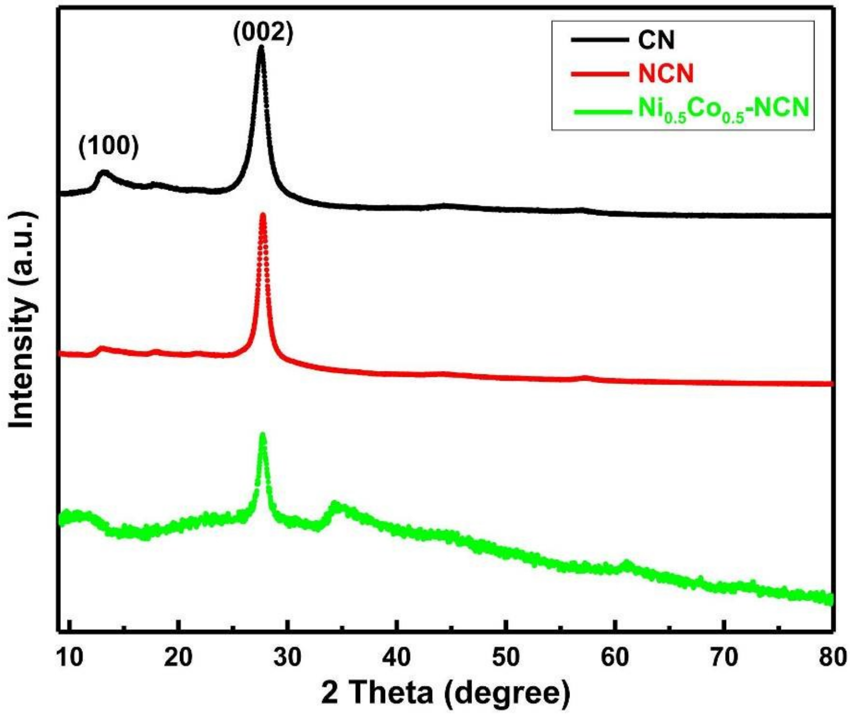

Figure S5: XRD spectra of CN, NCN and $Ni_{0.5}Co_{0.5}O$-NCN.

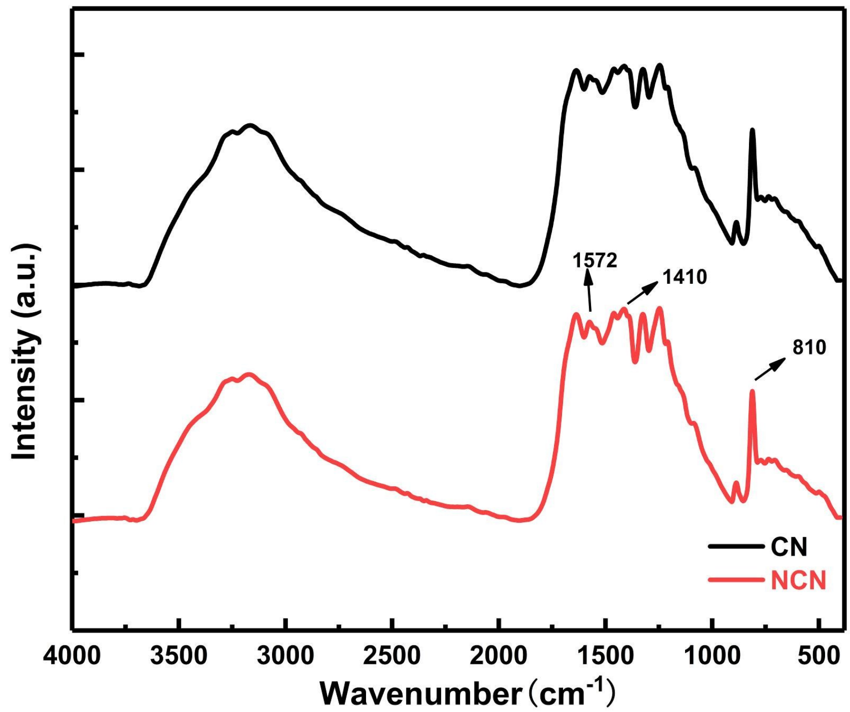

Figure S6: FTIR spectra of CN and NCN.

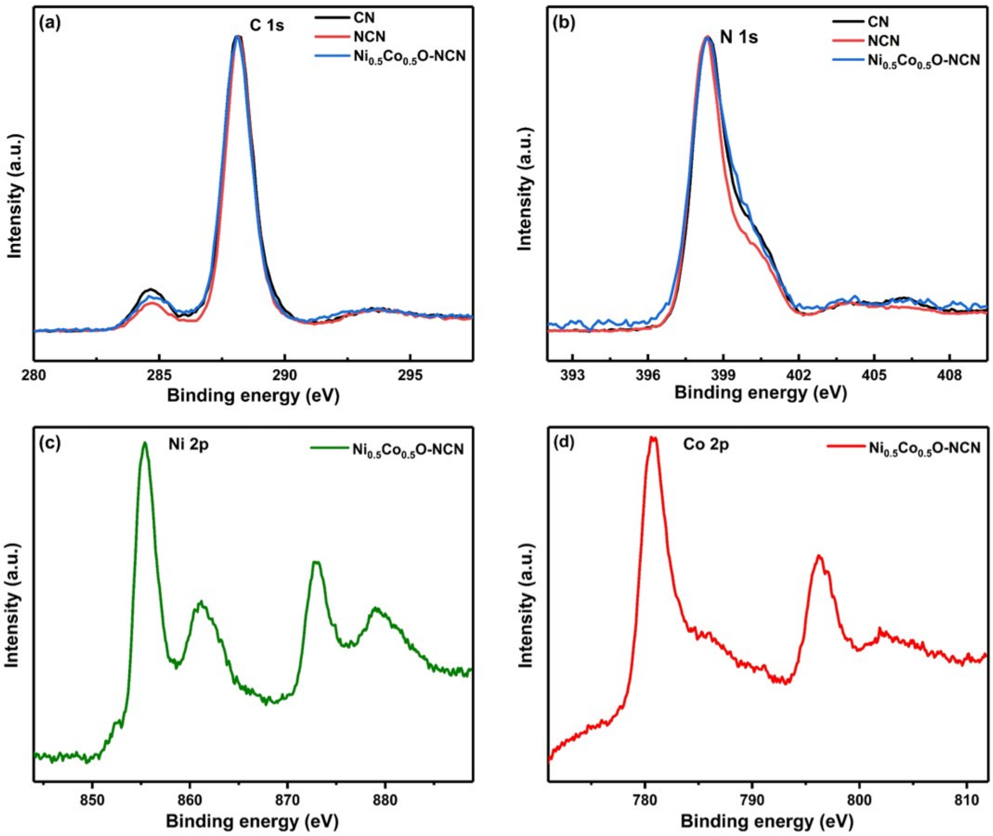

Figure S7: XPS spectra of CN, NCN and $Ni_{0.5}Co_{0.5}O$-NCN at C 1s (a), N 1s (b), Ni 2p (c) and Co 2p (d) edges, respectively.

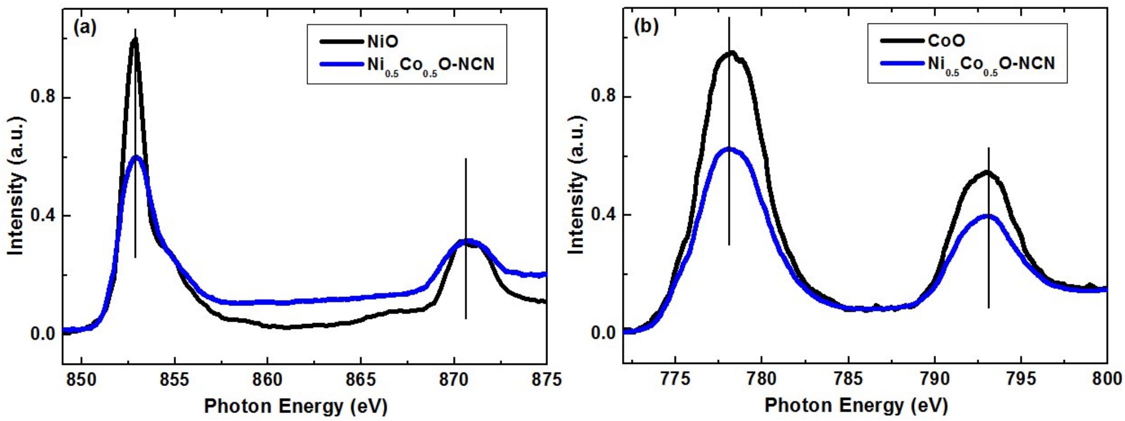

Figure S8: XAS spectra of $Ni_{0.5}Co_{0.5}O$-NCN and the reference samples at Ni *L*-edge (a) and Co *L*-edge (b), respectively.

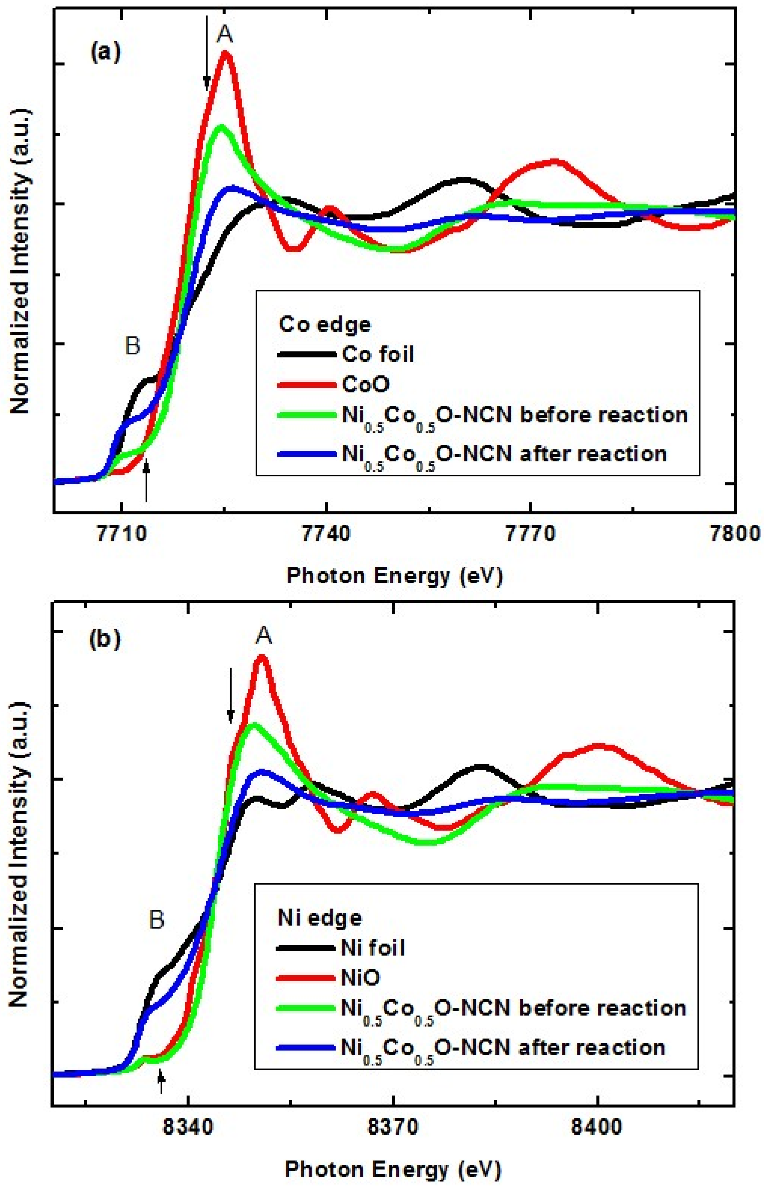

Figure S9: XAS spectra of $Ni_{0.5}Co_{0.5}O$-NCN before and after the hydrolysis reaction at Co *K*-edge (a) and Ni *K*-edge (b), respectively.

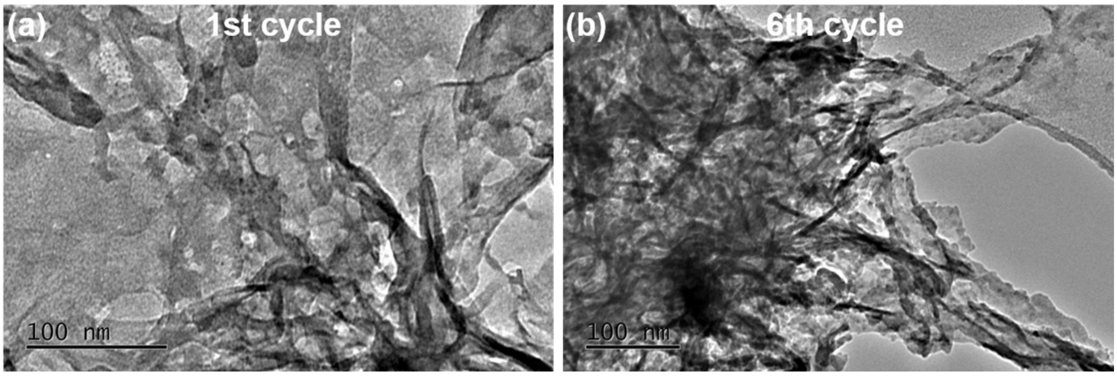

Figure S10: TEM images of the $Ni_{0.5}Co_{0.5}O$-NCN samples after the first cycle (a) and the 6th cycle (b).

Samples	Ni-loading/wt%	Co-loading/wt%	TOF (H_2) mol/(Cat-M)mol·min
$Ni_{0.8}Co_{0.2}O$-NCN	17.1	4.3	42.9
$Ni_{0.6}Co_{0.4}O$-NCN	12.2	8.4	50.3
$Ni_{0.5}Co_{0.5}O$-NCN	11.6	10.5	76.1
$Ni_{0.4}Co_{0.6}O$-NCN	8.7	12.8	46.6
$Ni_{0.2}Co_{0.8}O$-NCN	3.9	16.2	35.2
NiO-NCN	19.1	-	5.5
CoO-NCN	-	15.8	13.3
NCN	-	-	0

Table S1. Ni and Co contents and the TOF values of various $Ni_xCo_{1-x}O$-NCN samples.

Catalyst	TOF (H_2) mol/(Cat-M)mol·min	Solution	T (°C)	Ref.
$Ni_{0.5}Co_{0.5}O$-NCN	76.1	Water	25	This work
$Cu_{0.72}Co_{0.18}Mo_{0.1}$	119.0	NaOH	25	1
Co/MIL-101(Cr)-NH_2	117.7(light)	Water	25	2
$Ni_{0.3}Co_{1.3}P$/GO	109.4	NaOH	25	3
Co-C_3N_4-580	93.8(light)	Water	25	4
Ni/ZIF-8	85.7	NaOH	25	5
$Cu_{0.5}Co_{0.5}O$-rGO	81.7	Water	25	6
CuCo/g-C_3N_4	75.1(light)	Water	25	7
CoP	72.2	NaOH	25	8
$Cu_{0.8}Co_{0.2}O$-GO	70.0	Water	25	9
Ni0.9Mo0.1/graphene	66.7	Water	25	10
CuO-NiO	60.0	Water	25	11
$Cu_{0.5}Ni_{0.5}$/CMK-1	54.8	Water	25	12
CuCo/MIL-101-1-U	51.7	Water	25	13
Co NPs (in-situ)	49.8	Water	25	14
Ni NPs@3D-(N)GFs	41.7	Water	25	15
Ni_2P	40.4	Water	25	16
Cu NPs@SCF	40.0	Water	25	17
PEI-GO/Co	39.9	Water	25	18
Ni@MCS-30	30.7	Water	25	19
$Cu_{0.49}Co_{0.51}$/C	28.7	Water	25	20
Ni NPs/CNT	23.5	Water	25	21
$Cu_{0.1}$@$Co_{0.45}Ni_{0.45}$/graphene	15.46	Water	25	22
Ni NPs/C	8.8	Water	25	23

Cu/rGO	**3.6**	**Water**	**25**	**24**

Table S2: Activities of various non-noble metal based catalysts for the hydrolysis of AB.

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Cycles	TOF (H_2) mol/(Cat-M)mol·min	Catalytic Efficiency
1^{st}	76.1	100%
2^{nd}	73.9	97.1%
3^{rd}	71.5	94.0%
4^{th}	69.0	90.7%
5^{th}	66.3	87.1 %
6^{th}	63.3	83.2%

Table S3. TOF values and the catalytic efficiencies of $Ni_{0.5}Co_{0.5}O$-NCN in different cycles during the stability test.