Supporting Information

Synergetic interface between metal Cu nanoparticles and CoO for highly efficient hydrogen production from ammonia-borane

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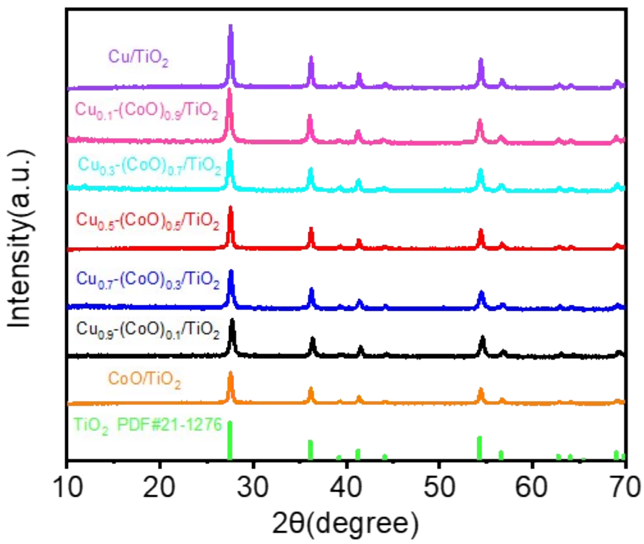

Figure S1. XRD patterns of different catalysts.

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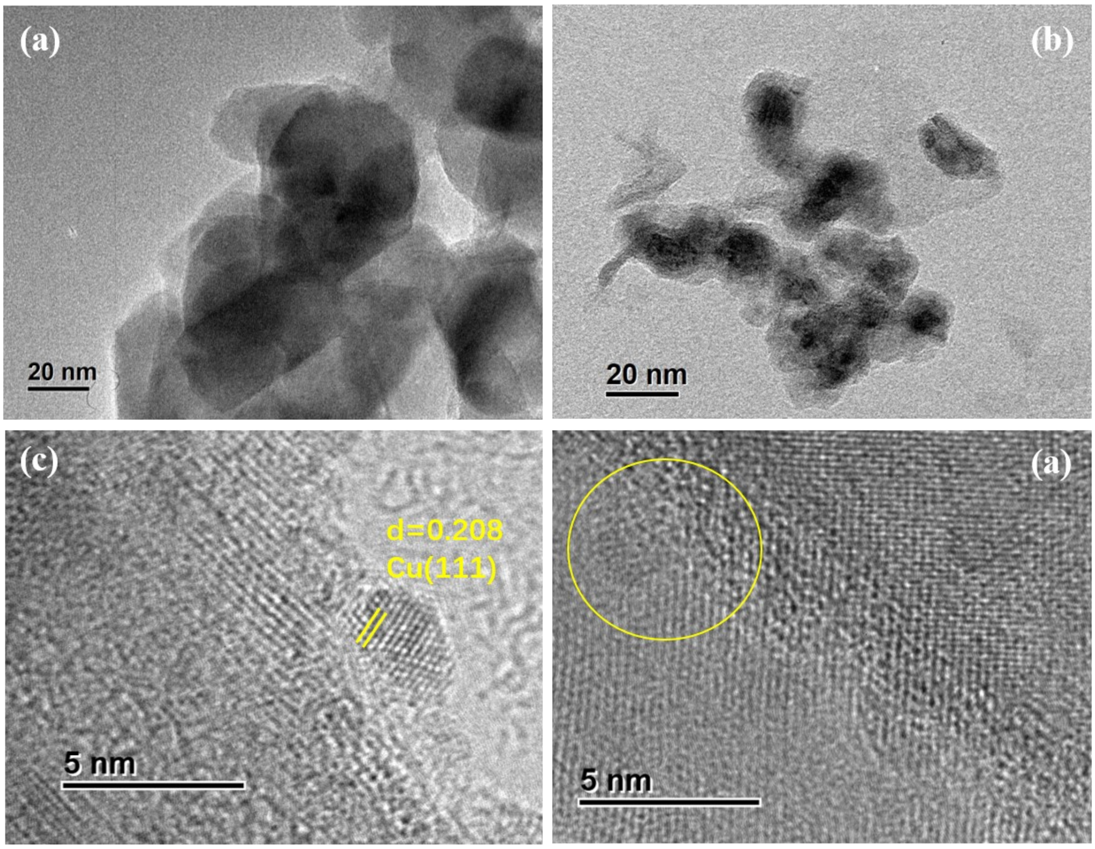

Figure S2. TEM images of (a) TiO_2 and (b) $Cu_{0.5}$-$(CoO)_{0.5}$. HRTEM images of (c) Cu/TiO_2 and (d) CoO/TiO_2.

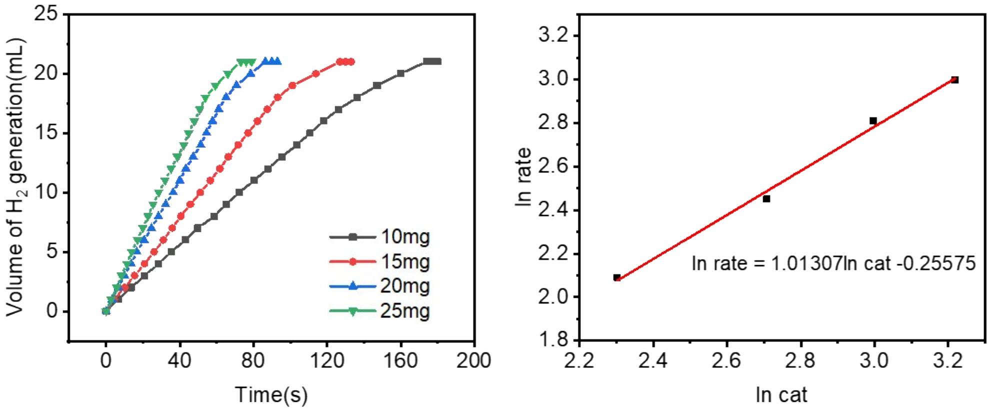

Figure S3. Hydrogen production over time for the hydrolysis of ammonia borane catalyzed by $Cu_{0.5}$-$(CoO)_{0.5}/TiO_2$ at different catalysts amounts (left), and the relationships between the H_2 generation rate and catalysts amounts in natural logarithmic scale (right).

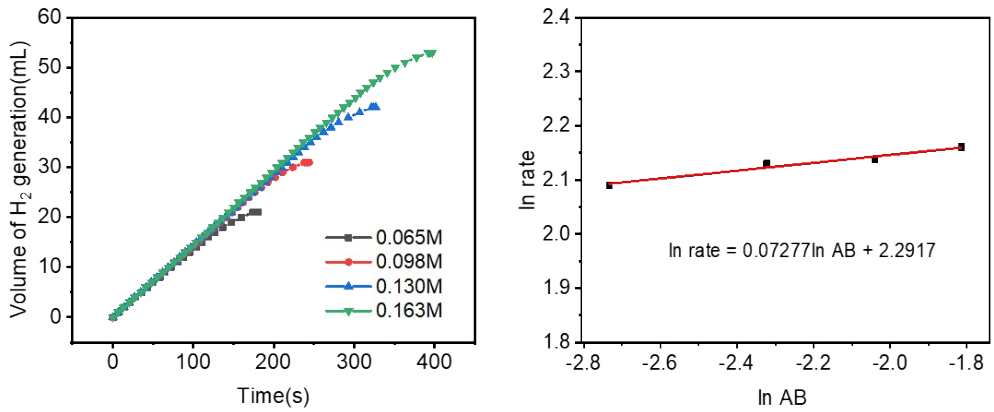

Figure S4. Hydrogen production over time for the hydrolysis of ammonia borane catalyzed by $Cu_{0.5}$-$(CoO)_{0.5}/TiO_2$ at different ammonia borane concentrations (left), and the relationships between the H_2 generation rate and ammonia borane concentrations in natural logarithmic scale (right).

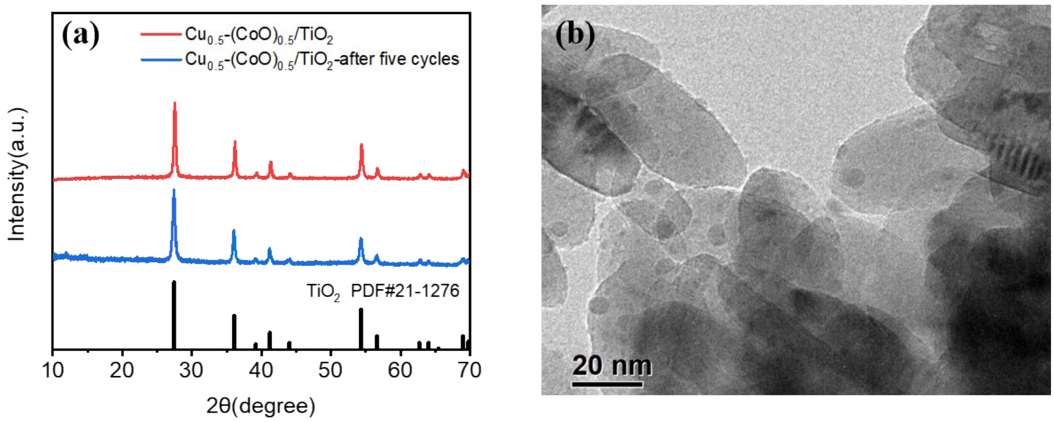

Figure S5. The (a) XRD patterns and (b) TEM images of $Cu_{0.5}$-$(CoO)_{0.5}/TiO_2$ after five cycles.

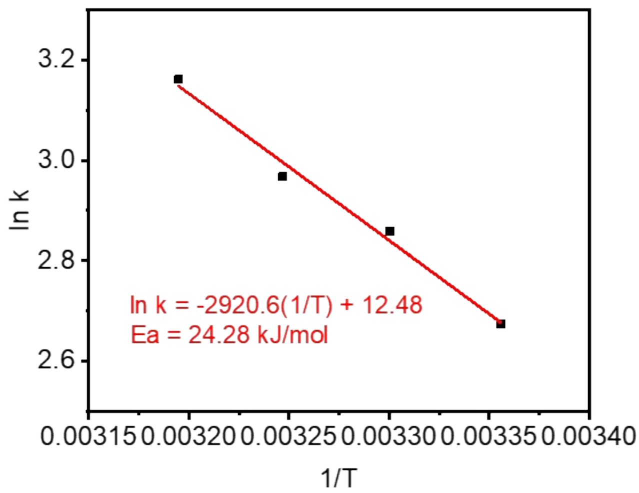

Figure S6. The Arrhenius plot and the E_a of $Cu_{0.5}$-$(CoO)_{0.5}/TiO_2$ for hydrolysis of ammonia borane in 0.2 M NaOH within the temperature range from 298 to 313 K.

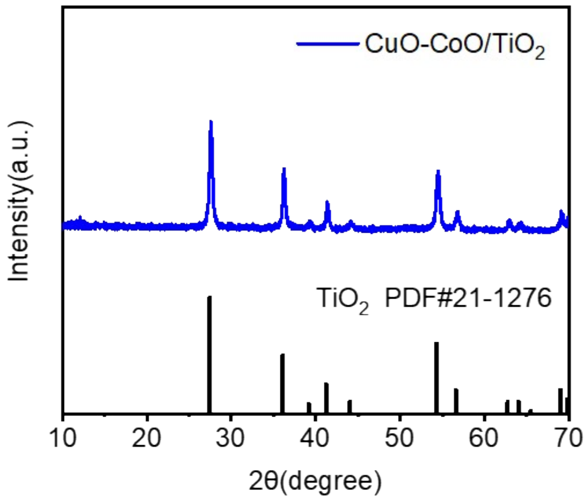

Figure S7. XRD pattern of CuO-CoO/TiO_2.

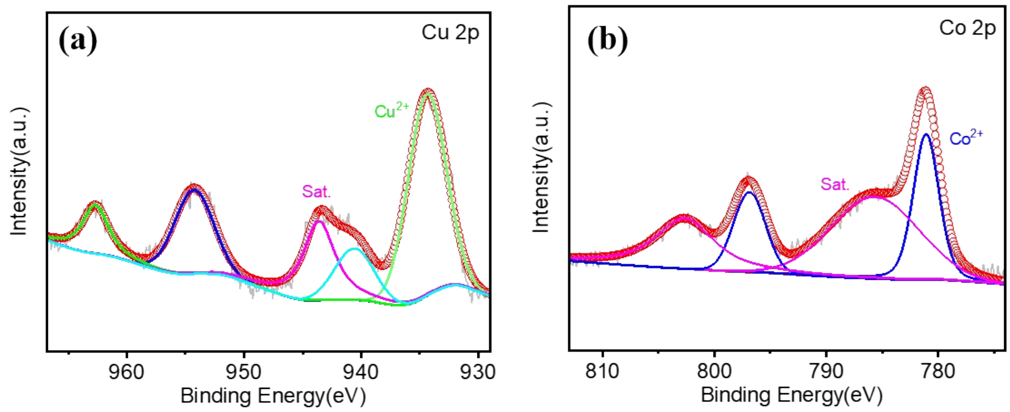

Figure S8. The high-resolution XPS spectra of (a) Cu 2p and (b) Co 2p of CuO-CoO/TiO_2.

Table S1. The content of Co and Cu in samples by ICP-AES.

Sample	Cu (wt%)	Co (wt%)
CoO/TiO_2	0	5.0
$Cu_{0.1}$-$(CoO)_{0.9}/TiO_2$	0.6	4.6
$Cu_{0.3}$-$(CoO)_{0.7}/TiO_2$	1.8	3.6
$Cu_{0.5}$-$(CoO)_{0.5}/TiO_2$	2.9	2.5
$Cu_{0.7}$-$(CoO)_{0.3}/TiO_2$	4.4	1.7
$Cu_{0.9}$-$(CoO)_{0.1}/TiO_2$	5.6	0.6
Cu/TiO_2	5.7	0
CuO-CoO/TiO_2	3.0	2.7
$Cu/TiO_2 + CoO/TiO_2$	2.9	2.5
$Cu_{0.5}$-$(CoO)_{0.5}$	46.1	36.2

Table S2. TOF values of different catalysts.

Catalysts	TOF (mol_{H2} mol_{metal}^{-1} min^{-1})
$Cu_{0.1}$-$(CoO)_{0.9}/TiO_2$	14.9
$Cu_{0.3}$-$(CoO)_{0.7}/TiO_2$	23.4
$Cu_{0.5}$-$(CoO)_{0.5}/TiO_2$	40.8
$Cu_{0.7}$-$(CoO)_{0.3}/TiO_2$	20.3
$Cu_{0.9}$-$(CoO)_{0.1}/TiO_2$	16.2
CoO/TiO_2	0.0
Cu/TiO_2	1.0
CuO-CoO/TiO_2	19.0
Cu/TiO_2 + CoO/TiO_2	9.9
$Cu_{0.5}$-$(CoO)_{0.5}$	2.4

Table S3. TOF values of different non-noble metal catalysts reported in the literature.

Catalysts	TOF ($mol_{H2}\ mol_{metal}^{-1}\ min^{-1}$)	T (K)	Ref.
$Cu_{0.72}Co_{0.18}Mo_{0.1}$ NPs	119.0 [a]	298	1
$Cu_{0.5}$-$(CoO)_{0.5}/TiO_2$	104.0 [a]	298	This work
Cu@CuCoOx	98.2 [a]	298	2
Ni/ZIF-8	85.7 [a]	298	3
CuO–NiO/Co_3O_4	79.1 [a]	298	4
Cu-Ni-Co@MIL-101	72.1	298	5
$Cu_{0.8}Co_{0.2}O$-GO	70	298	6
$Cu_{0.6}Co_{0.4}O$@CN	57.7 [a]	298	7
$Cu/Cu_{0.76}Co_{2.24}O_4$-V60	50.33 [a]	298	8
$Cu_{0.5}$-$(CoO)_{0.5}/TiO_2$	40.8	298	This work
CoCuO@CoCu-C	38 [a]	298	9
CuNi/Co_3O_4	31.5 [a]	298	10
$Cu_{0.5}Co_{0.5}$/PDDA-HNT	30.8	298	11
Ni@MSC-30	30.7	298	12
CoCu/Ni	30.5 [a]	298	13
$N_{i0.9}Mo_{0.1}$ NPs	27.3	298	14
MoO_3-doped $MnCo_2O_4$	26.4 [a]	298	15
$Ni_{0.75}Cu_{0.25}$/47-SiO_2	25.3	298	16
Co@Ni-MOF NCA	20.54	298	17
CuCo NPs@MIL-101	19.6	298	18
$Co_{40}Cu_{60}$@S16LC-20	16.36	298	19
Co/$CoFeO_X$-25	12.25	298	20
CuCo NPs/graphene	9.18	298	21
$Cu_{0.4}Co_{0.6}$ NPs/BNNFs	8.42	298	22
Co@N–C-700	5.6	298	23

[a]The reaction was tested in the presence of NaOH.

Table S4. The area and proportion of each atom measured by XPS of CuO-CoO/TiO_2.

Name	Area (P)	Atomic percentage (%)
Cl 2p	693.73	0.2
Ti 2p	187515.12	25.9
O 1s	211056.32	67.3
Co 2p	72649.99	4.1
Cu 2p	58021.11	2.5

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