Supplementary Information

Sustainable natural nanofibrous confinement strategy to ultrafine Co_3O_4 nanocatalysts embedded in N-enriched carbon fibers for efficient biomass-derivatives *in situ* hydrogenation

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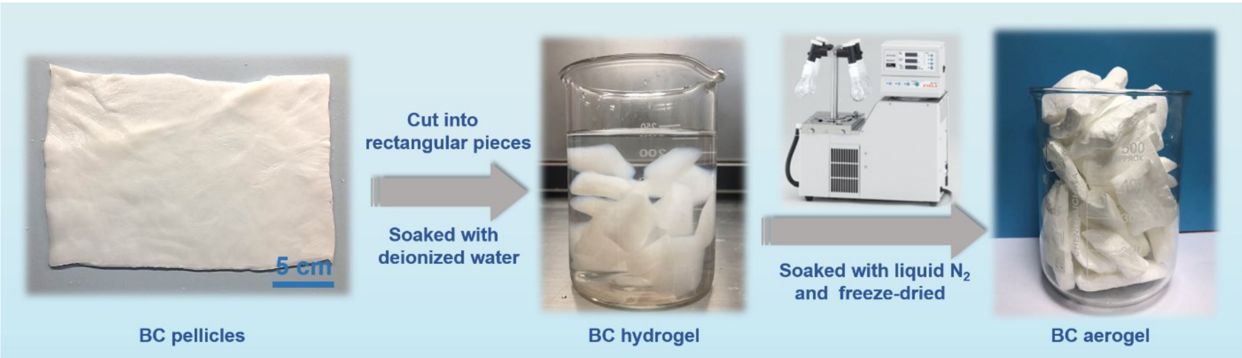


Fig. S1 Schematic illustration for the preparation of BC aerogel.

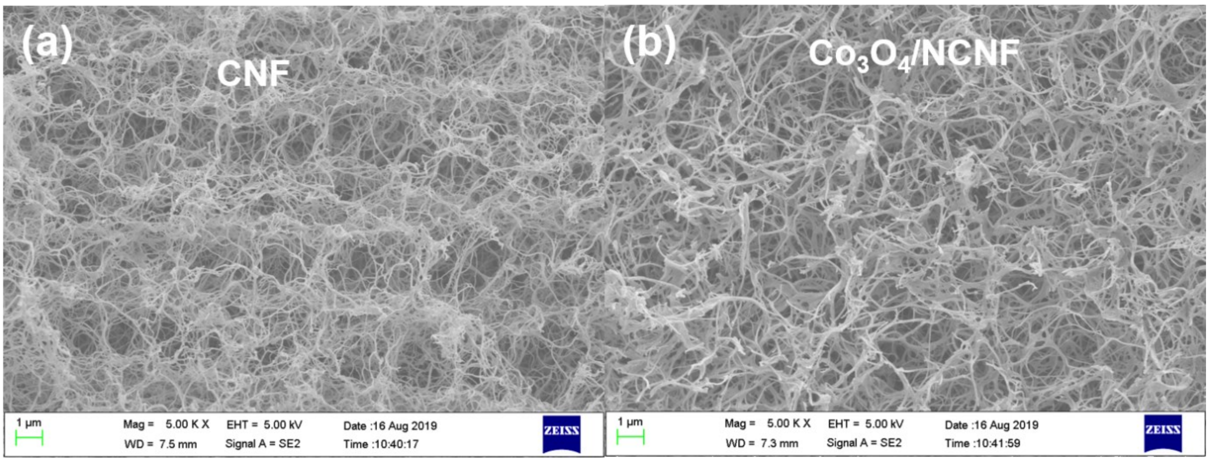


Fig. S2 SEM images of CNF (a), Co_3O_4/NCNF (b).

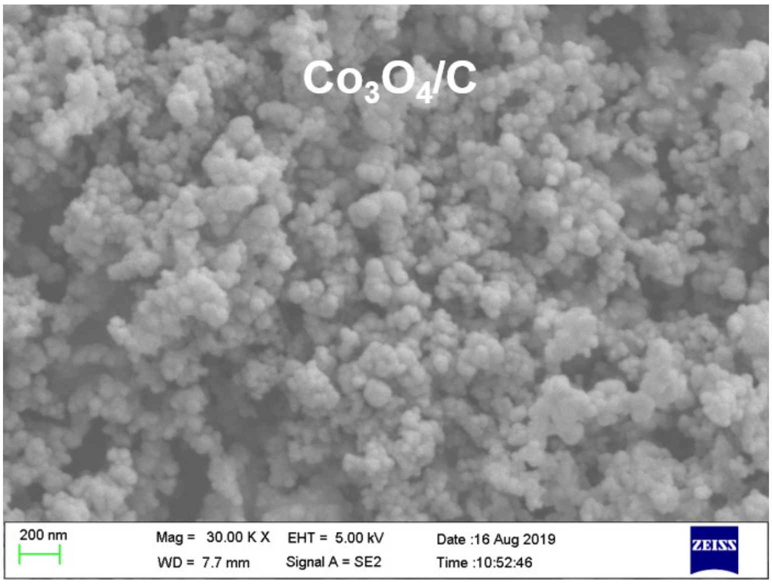


Fig. S3 SEM images of Co_3O_4/C.

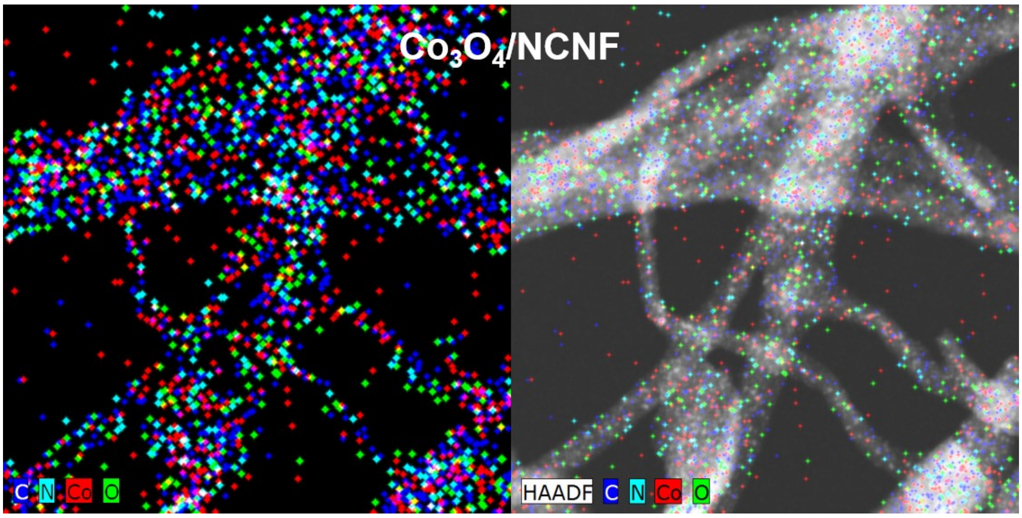


Fig. S4 TEM element mapping images (d) of Co_3O_4/NCNF.

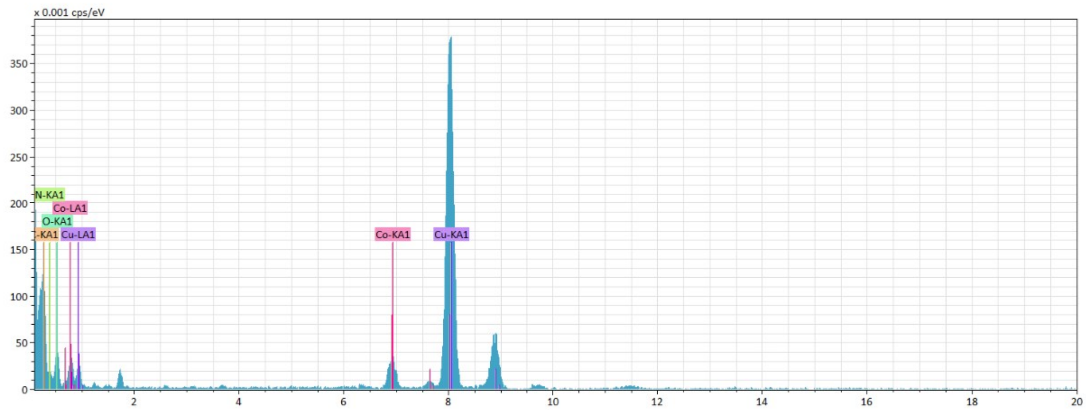


Fig. S5 HRTEM-EDX of Co_3O_4/NCNF.

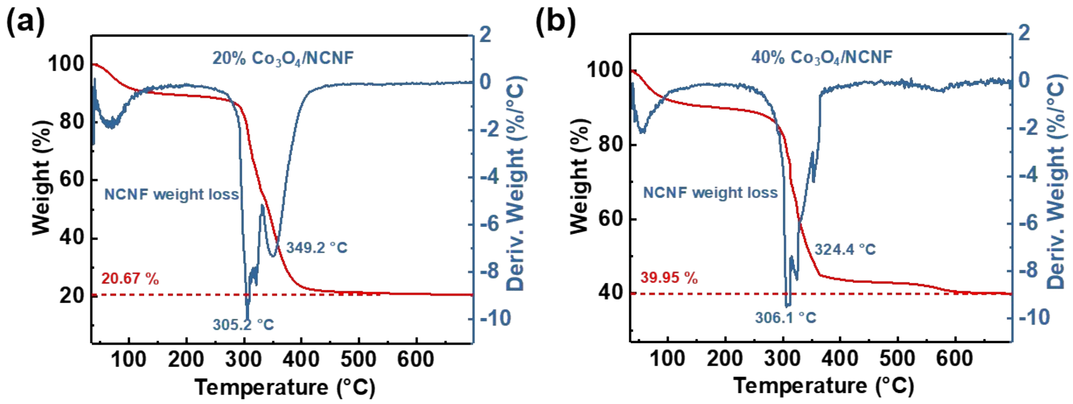


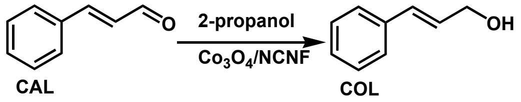
Figure S6 TG and DTG curves of BC and 20% and 40% Co_3O_4/NCNF.

Table S1 The results of elemental analysis for various catalysts

Catalysts	Content (wt.%) [a]		
	C	N	H
BC	36.3	1.1	5.0
Co_3O_4/C	43.6	0.4	1.1
Co_3O_4/CNF	44.9	1.2	2.1
Co_3O_4/NCNF	48.4	6.3	2.0

[a] Determined by elemental analysis.

Table S2 Catalytic results for different catalysts [a]



Entry	Catalysts	Conv. (%)	COL Sel. (%) [b]
1	Blank	0.2	100
2	Co_3O_4	3.1	99
3	C	0.4	99
4	CNF	1.4	99
5	NCNF	4.6	99
6	Co_3O_4/NCNF	36.8	99
7	Mn_3O_4/NCNF	30.25	99
8	Fe_3O_4/NCNF	8.3	99
9	NiO/NCNF	9.9	99
10 [c]	Co_3O_4+ NCNF	8.2	99

[a] Reaction conditions: 0.5mmol CAL in 5ml 2-propanol, 50mg catalyst, 160 °C, 3h.

[b] The by product is phenylpropanol. [c] Co_3O_4 and NCNF were physically mixed.

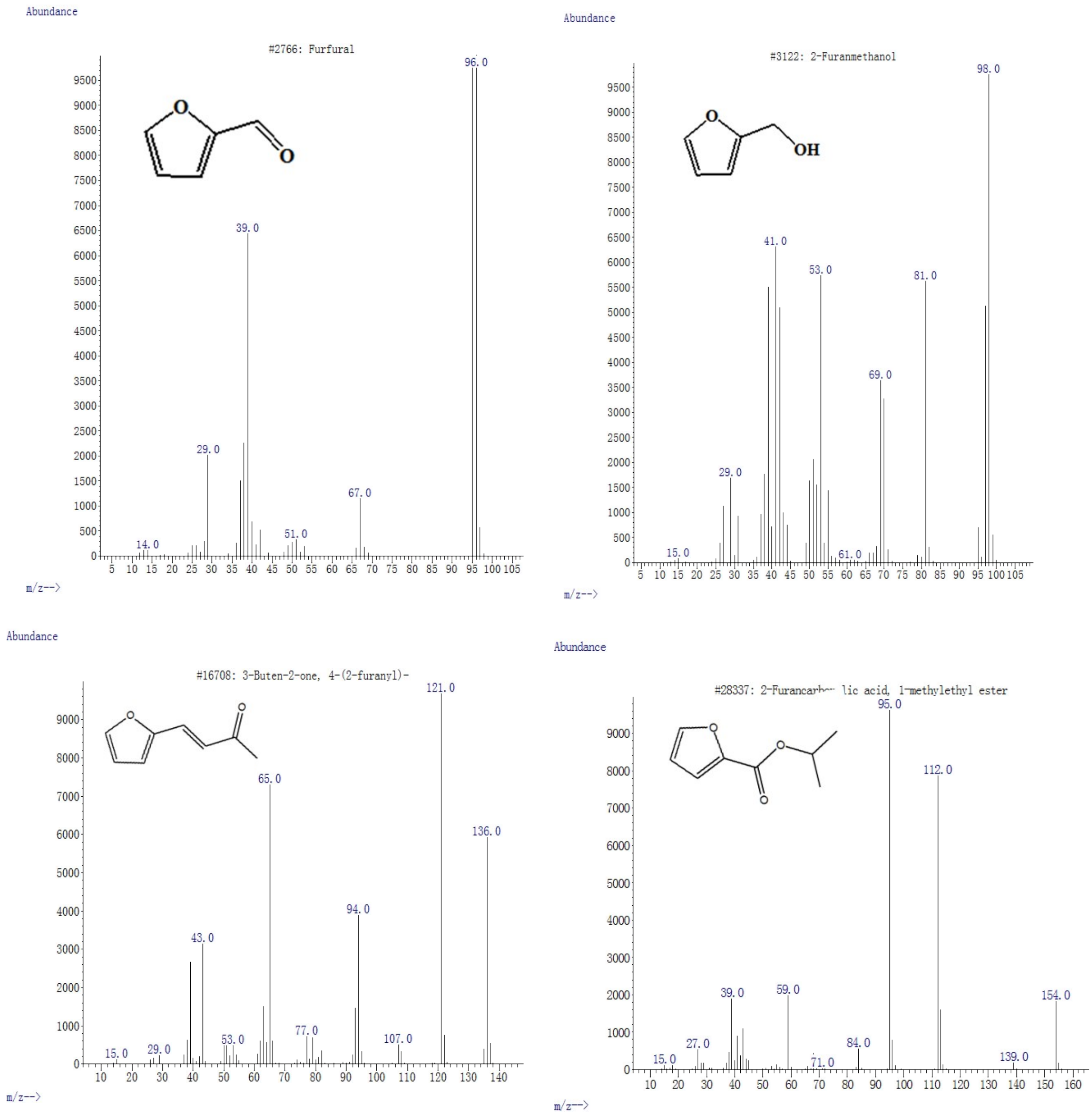


Fig. S7 Representative MS spectra of the reaction mixture in FAL hydrogenation.

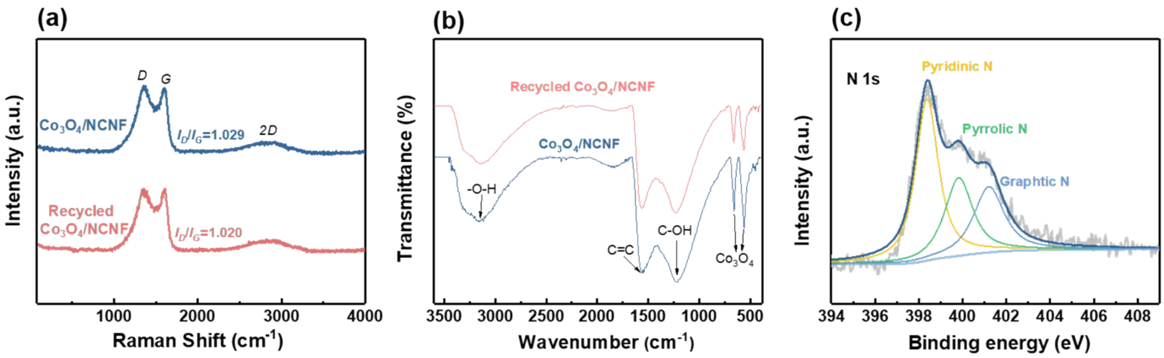


Fig. S8 Raman spectra (a) and FT-IR spectra (b) of Co_3O_4/NCNF before and after the reaction. N 1s spectrum (c) of recycled Co_3O_4/NCNF.

Table S3 The results of elemental analysis for various catalysts

Catalysts	Content (wt.%)			
	Co [a]	N [b]	C [b]	O [b]
Co_3O_4/NCNF	2.93	4.66	79.85	12.55
Recycled Co_3O_4/NCNF	2.67	4.2	76.64	16.48

[a] Determined by ICP-OES.

[b] Determined by elemental analysis.

Table S4 The comparison of Co_3O_4 nanoparticle size with previously reported catalysts.

Entry	Sample	Co_3O_4 mean size	Application	Ref.
1	Co_3O_4/graphene	10-30 nm	Lithium-ion batteries	[1]
2	N-doped PC-Co_3O_4	5−10 nm	Lithium-ion batteries	[2]
3	R-Co_3O_4/C	3-10 nm	Sodium-Ion Batteries	[3]
4	NC-Co_3O_4	10–20 nm	Zinc–Air Batteries	[4]
5	Co_3O_4/rGO	30 nm	Li-ion batteries	[5]
6	Co_3O_4@NCFs	3–6 nm	lithium/sodium storage	[6]
7	Co_3O_4/N-PC	15–30 nm	lithium storage and water splitting	[7]
8	NCA/Co_3O_4	5–35 nm	Supercapacitors	[8]
9	Co_3O_4/CNFs	3-5 nm	Supercapacitor	[9]
10	Co_3O_4@C-MWCNTs	10–25 nm	OER and ORR	[10]
11	Co_3O_4-CNFs	20 - 40 nm	Electrodes	[11]
12	HCo_3O_4/C	6–12 nm	Peroxymonosulfate activation	[12]
13	Co_3O_4@C@PGC	10–20 nm	microwave absorber	[13]
14	Co_3O_4−N@C	2−10 nm	Catalysts	[14]
15	CoO_x@NCNTs	12.9 nm	Catalysts	[15]
16	Co_3O_4/MC	3 nm	Catalysts	[16]
17	Co_3O_4/carbon	8–25 nm	Catalysts	[17]
18	ZIF-Co_3O_4/NCF	5–8 nm	Catalysts	[18]
19	Co_3O_4/NCNFs	1.0-2.5 nm	Catalysts	This work

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Table S5 The comparison of CTH of CAL and FAL with H_2 or H-donor reaction systems with previously reported catalysts.

Entry	Catalyst	Substrate	H-donor	Reaction conditions	Conv. (%)	Sel. of alcohol (%)	Ref.
1	1.0Pt-5.3FeO_x /SiO_2-GD	CAL	1 MPa H_2	150 °C, 2 h	41	92	[19]
2	Pt-Re/rGO	CAL	2 MPa H_2	120 °C, 4 h	94.1	88.7	[20]
3	Au//In_2O_3	CAL	1 MPa H_2	180 °C, 18 h	91	84	[21]
4	CoPt/Fe_3O_4	CAL	3 MPa H_2, 2-propanol	160 °C, 3 h	95	84	[22]
5	Cu-Au/SiO_2	CAL	2 MPa H_2	100 °C, 3 h	55.0	53.0	[23]
6	Ni−Co/MWCNT	CAL	0.5 MPa H_2	150 °C, 8 h	62.6	62.1	[24]
7	Au/$Zn_{0.7}Fe_{0.3}$Ox	CAL	2-propanol, 1 MPa H_2	140 °C, 10 h	75.4	88.5	[25]
8	ZIF-67@SiO_2-CPTEOS	CAL	2-propanol, 1 MPa N_2	180 °C, 18 h	99	93.25	[26]
9	2%Pt-1%Re/TiO_2-ZrO_2	FAL	5 MPa H_2	130 °C, 8 h	100	95.7	[27]
10	Co/SBA-15	FAL	2 MPa H_2	150 °C, 1 h	80	96	[28]
11	Ni-Sn/AlOH	FAL	3 Mpa H_2	180 °C, 75 min	95	91	[29]
12	Cu:Zn:Cr:Zr(3:2:1:3)	FAL	2 MPa H_2	170 °C, 3.5 h	100	96	[30]
13	Fe-L4(L5)/C-800	FAL	2-propanol	160 °C, 15 h	91.6	83	[31]
14	$LaFeO_3$_N	FAL	2-propanol	180 °C, 3 h	-	-	[32]
15	Pd/Fe_2O_3	FAL	2-propanol	180 °C, 7.5 h	100	34	[33]
16	Cu/MgO-Al_2O_3	FAL	2-propanol	210 °C, 1 h,	100	89	[34]
17	$DyCl_3$	FAL	2-propanol	180 °C, 3 h, (2Mpa N_2)	98	97	[35]
18	Al_7Zr_3@Fe_3O_4	FAL	2-propanol	180 °C, 4 h	99.1	90.5	[36]
19	Fe_2O_3@HAP	FAL	2-propanol	180 °C, 10 h	96.2	95.3	[37]
20	$NiFe_2O_4$	FAL	2-propanol	180 °C, 6 h	99	95	[38]
21	Cu_2Al	FAL	methanol	200 °C, 2.5 h, (1Mpa N_2)	100	94	[39]
22	γ-Al_2O_3	FAL	2-propanol	150 °C, 6 h	100	90	[40]
23	e HT_MgFe-3	FAL	2-propanol	170 °C, 6 h	99	90	[41]
24	Co_3O_4/NCNF	CAL	2-propanol	160 °C, 5 h	100	95	This work
25	Co_3O_4/NCNF	FAL	2-propanol	160 °C, 2 h	91.0	88	This work
26	Co_3O_4/NCNF	FAL	2-propanol	160 °C, 3.5 h	99	85	This work

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