Two-step synthesis of a-$NiCu(OH)_2CO_3/Na_3NiCuCO_3PO_4$: A battery-type electrode for pseudocapacitor applications

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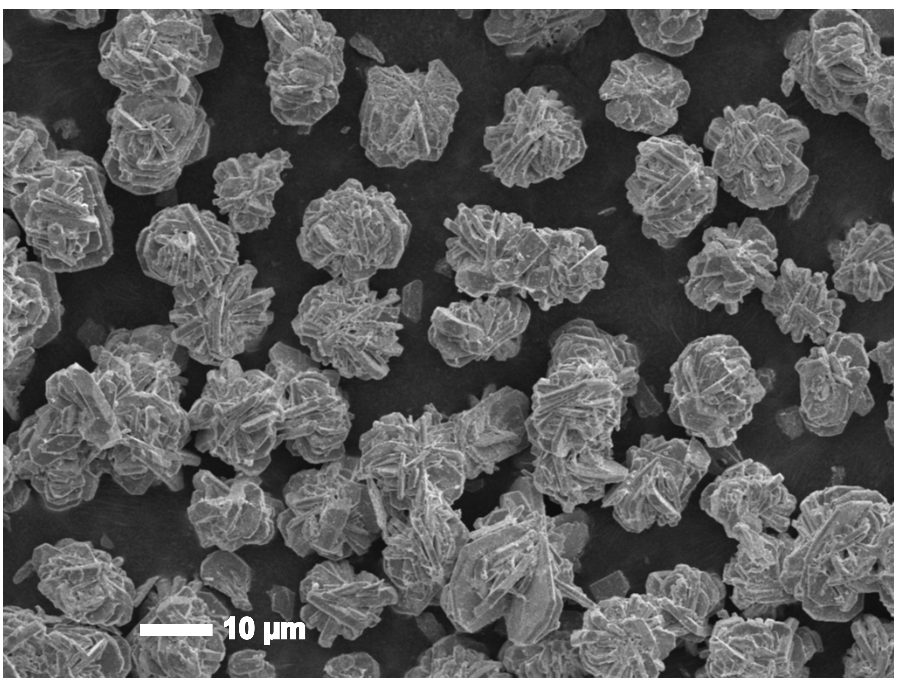

Fig. S1. FESEM image of a sample Ni:Cu-100:0 ($Na_3NiCO_3PO_4$).

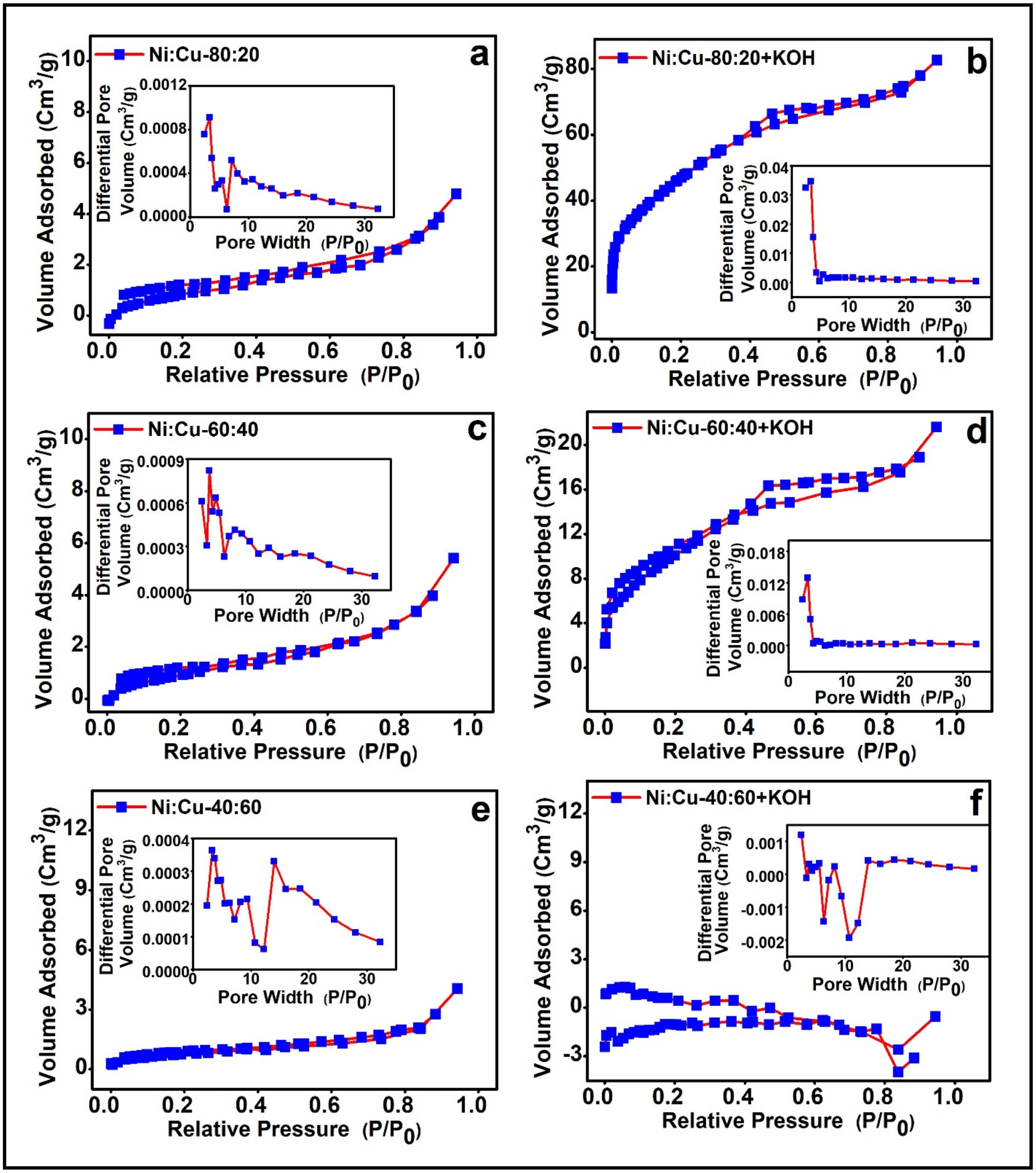

Fig. S2. N_2 adsorption-desorption isotherms of the $Na_3NiCuCO_3PO_4$ samples before and after KOH etching.

Table S1. Specific surface area, pore size and pore volume of the as-prepared and surface modified $Na_3NiCuCO_3PO_4$ particles.

Compound	pore size (nm)		pore volume (cm^3/g)	
	As prepared	Surface modified	As prepared	Surface modified
Ni:Cu-100:0	15.02	4.09	0.010679	0.1301
Ni:Cu-80:20	7.02	2.99	0.007775	0.0958
Ni:Cu-60:40	8.19	3.37	0.008703	0.0292
Ni:Cu-40:60	9.10	0.00	0.006260	0.0000

Table S2. The concentration of analyte in 1 M KOH electrolyte solution after $Na_3NiCuCO_3PO_4$ (Ni:Cu-80:20) electrode immersed in KOH solution for different time.

Technique	Element (in ppm)	Interaction with 1 M KOH solution		
		20 min	60 min	120 min
ICP-OES	P	34.7	37.3	41.1
	Na	500	543	587
	Ni	0.66	0.89	0.93
	Cu	2	2.3	2.7
IS 3025 (P-51) 2001 titration technique	C	1100	1318	1212

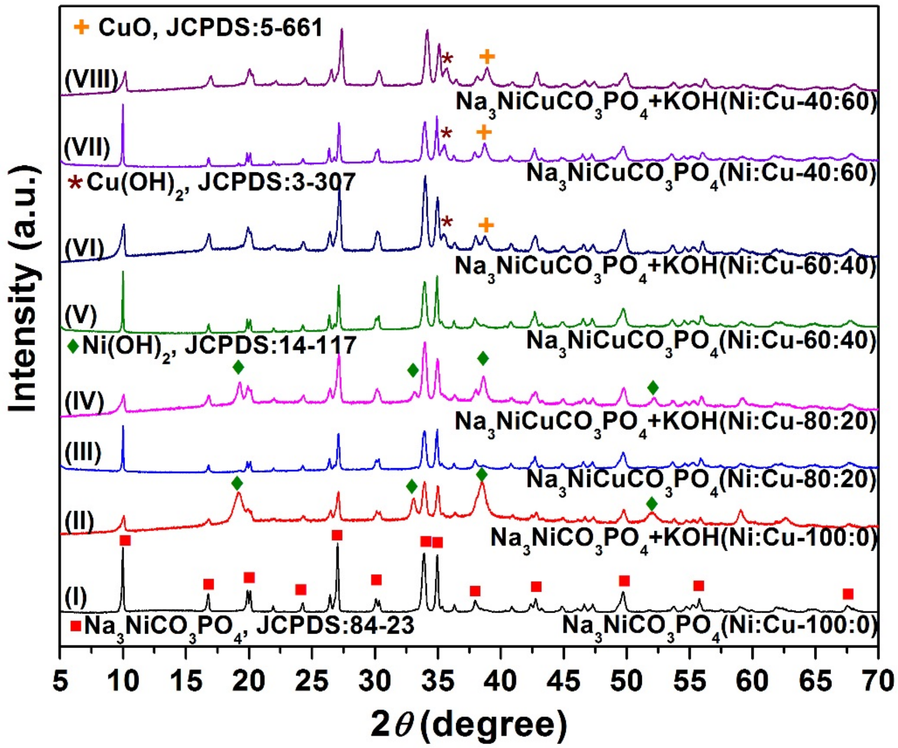

Fig. S3. Comparison of the XRD patterns of the $Na_3NiCuCO_3PO_4$ before and after KOH etching.

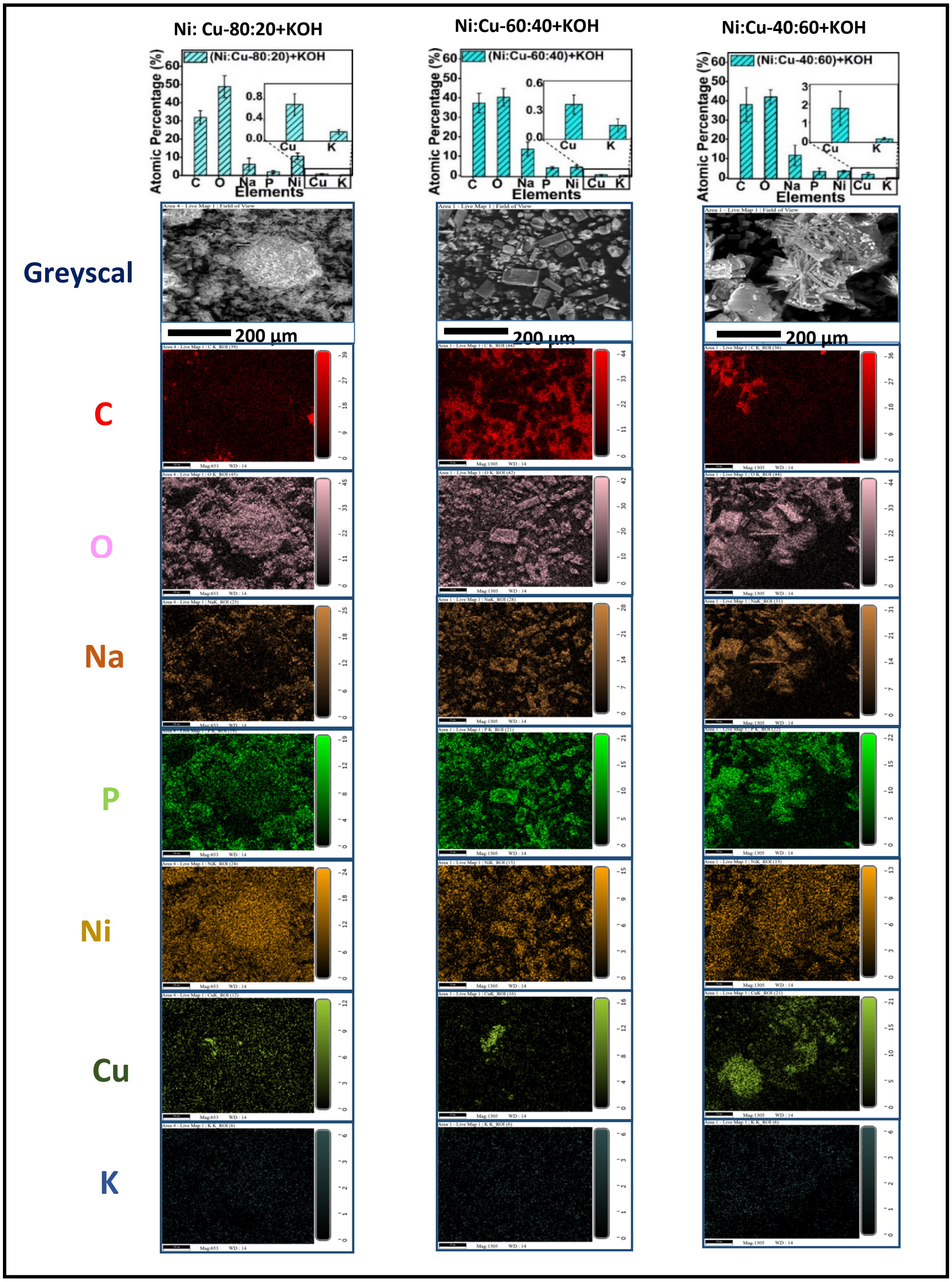

Fig. S4. FESEM elemental mapping of different elements at different electrochemical processing state.

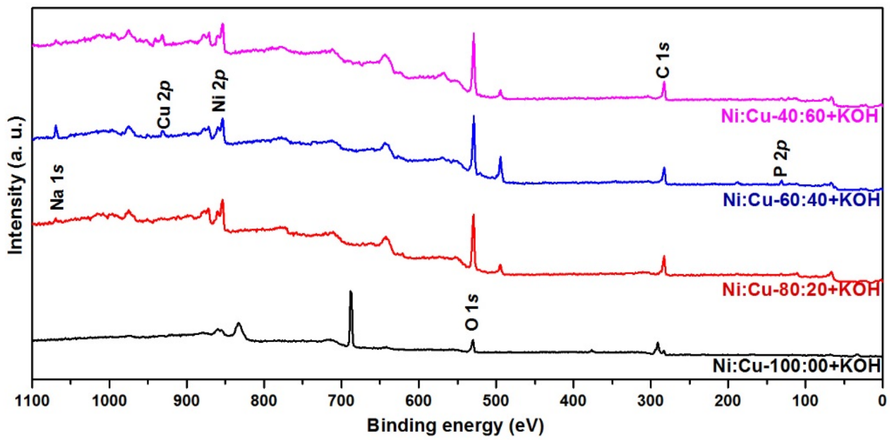

Fig. S5. The survey spectra acquired for $Na_3NiCuCO_3PO_4$ samples after KOH etching.

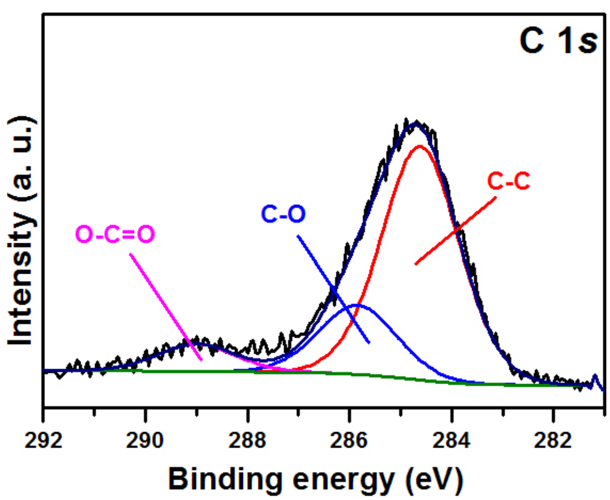

Fig. S6. High resolution C 1S spectrum of a Ni:Cu-80:20+KOH sample.

Table S3. XPS analysis data of various elements present in the KOH etched samples.

Elements (in at. %)	1 M KOH etched samples			
	Ni:Cu-100:00+KOH	Ni:Cu-80:20+KOH	Ni:Cu-60:40+KOH	Ni:Cu-40:60+KOH
Na 1*s*	-	0.85	3.21	0.98
Ni 2*p*	12.02	5.25	7.45	7.51
Cu 2p	-	0.31	1.00	2.98
C 1*s*	19.63	44.84	37.26	39.16
P 2*p*	-	2.47	6.42	3.52
O 1*s*	37.73	46.28	44.66	45.87

Table S4. Spectral fitting parameters for Ni $2p_{3/2}$: Relative peak positions, FWHM and % contributions for Ni^0 and Ni^{2+} GS envelopes for Ni:Cu-80:20+KOH sample.

Species	Charged State			
	Relative peak positions (in eV)	FWHM (in eV)	% contributions	Total %
Ni^0	852.5	1.0	0.27	
	856.2	2.5	4.06	5.6
	858.6	1.8	1.27	
NiO	853.7	1.5	1.01	
	855.4	3.2	1.33	
	860.8	3.9	2.30	5.86
	863.9	2.0	1.22	
$Ni(OH)_2$	854.8	1.1	2.69	
	855.7	2.3	22.32	
	857.6	1.6	3.69	88.54
	860.3	3.0	0.68	
	861.5	4.6	22.01	
	866.3	3.0	37.15	

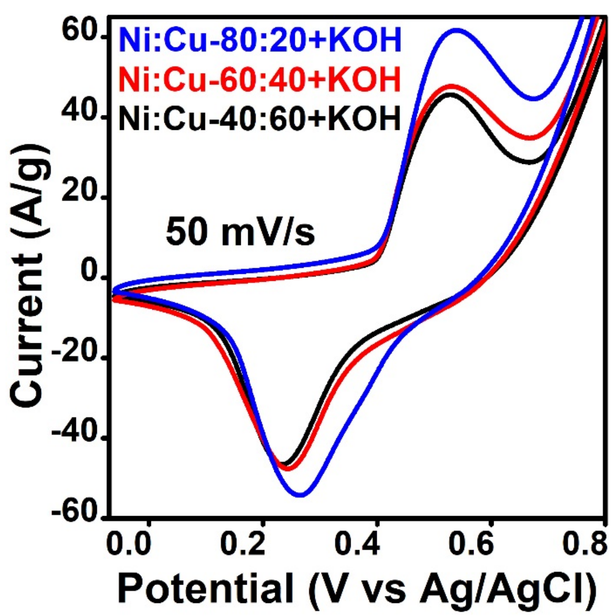

Fig. S7. CV profiles of KOH etched $Na_3NiCuCO_3PO_4$ samples in 1 M KOH solution obtained at 50 mV/s scan rate.

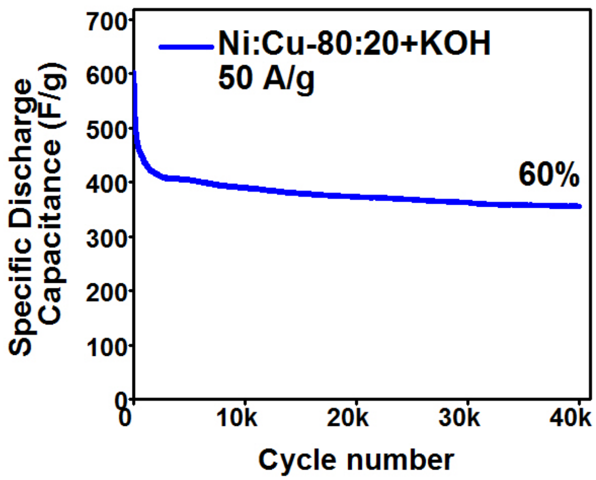

Fig. S8. The cycling stability of Ni:Cu-80:20+KOH in 1 M KOH electrolyte at 50 Ag^{-1} for 40000 cycles.

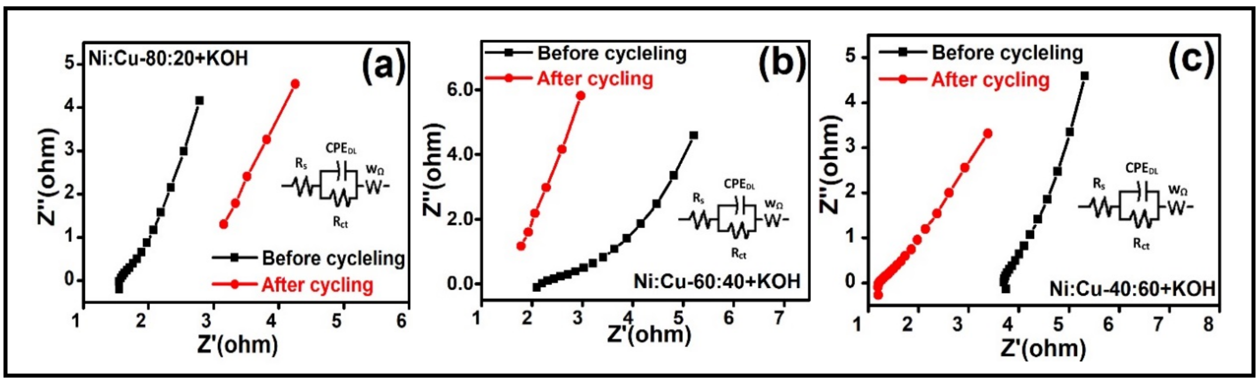

Fig. S9. (a) The Nyquist plots for the KOH etched samples before and after 15000 cycles at 10 Ag^{-1}.

Table S5. EIS fitting results for different KOH etched $Na_3NiCuCO_3PO_4$ samples in 1 M KOH solution before charge-discharge cycling.

Materials	R_s (Ωcm^2)	R_{ct} (Ωcm^2)	W_Ω (Ωcm^2)	CPE_{DL} ($\mu F cm^{-2}$)
Ni:Cu-80:20+KOH	1.50	3.85	0.01037	94.85
Ni:Cu-60:40+KOH	2.32	12.11	0.003379	153.9
Ni:Cu-40:60+KOH	3.59	35.99	0.007009	98.81

Table S6. Comparison of electrochemical performance of Ni-Cu composite materials based asymmetric supercapacitors

Electrode Materials	Electrolyte	Specific Capacitance (F/g) at 1 A/g	Cycles (5 A/g)	Retention (%)	Energy Density of SCs (Wh/Kg)	Power Density of SCs (W/Kg)	References
$NiCu(OH)_2CO_3$	6 M KOH	476	2000	88	48.55	541	1
Ni-Cu oxides ǁ rGO	1 M KOH	197 (0.5 A/g)			49	1816	2
$(Ni_{0.89}Cu_{0.11})_2(OH)_2CO_3$ ǁ AC	2 M KOH	96.06	4000	70.8	21.7	8407.4	3
NiCu- hybrid ǁ AC	1 M KOH	2420 mC/cm^2 (2 mA/cm^2)			420 $\mu Wh/cm^2$	2297 $\mu W/cm^2$	4
$NiCu(OH)_2CO_3$ ǁ AC	2 M KOH	163.7 (0.6 A/g)	5000 (2 A/g)	88.8	19.5	3789.5	5
$NiCu(CO_3)(OH)_2$ ǁ graphene	1 M KOH	758.9 mA h g^{-1} (3 A/g)	5000 (3 A/g)	87.2	26.7	2534	6
$MoS_2/NiCo(OH)_2CO_3$ ǁ AC	2 M KOH	1296	2000 (1 A/g)		16.4	375	7
Co/Ni hydroxide/CNT paper	6 M KOH	1497 (0.5 A/g)	5,000	--	-	-	8
PAN@$NiCu(CO_3)(OH)_2$ II graphene	2 M KOH	870 mAh g^{-1} (3 A/g)	5000 (1 A/g)	90.1	90	835	9
core/shell $Na_3NiCuCO_3PO_4$	1 M KOH	2647.9	40000	79	30.6	1555	This work

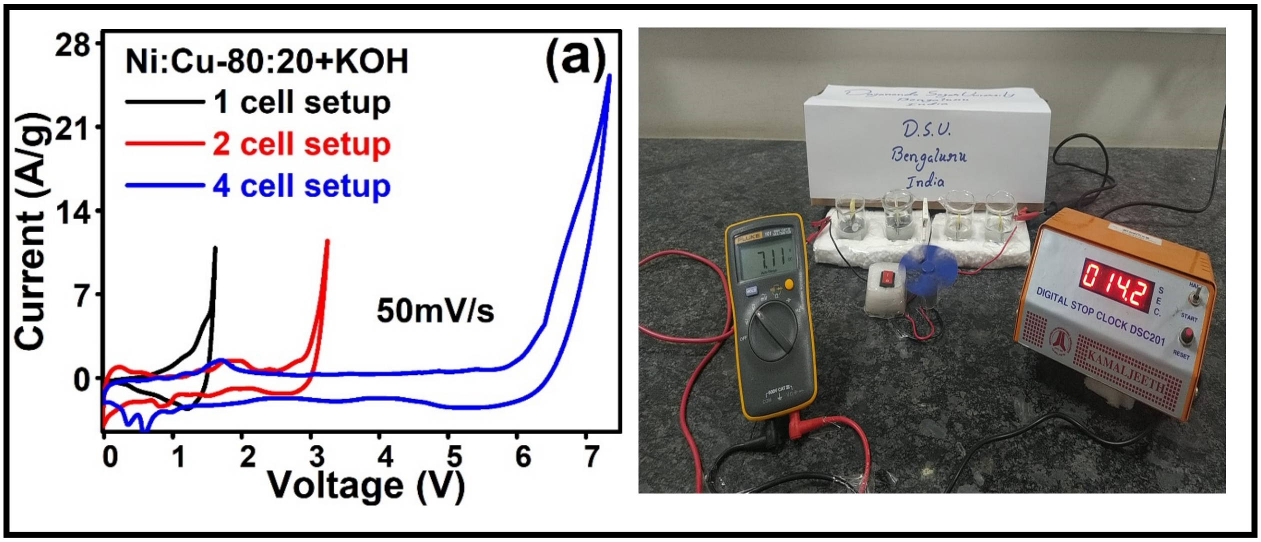

Fig. S10. (a) GCD curves of single, two and four SSCs in series at current density 1 A/g (b) photograph of tandem (four cells in series) SC powering the 6V DC motor fan.

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