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

Supporting Information

Modified Chalcogens with Tuned Nano-Architecture for High Energy Density and Long Life Hybrid Super Capacitor

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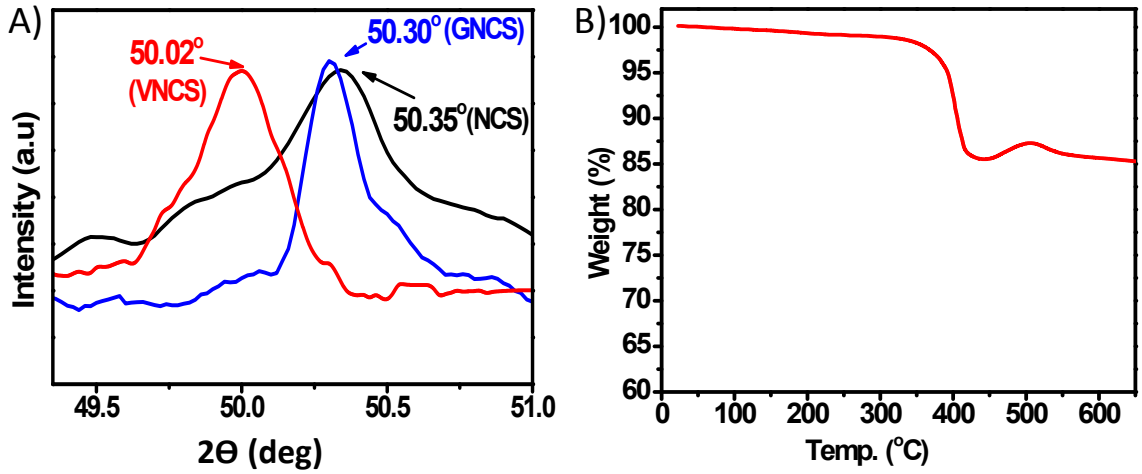

Figure S 1. A) XRD shift of plane (511), B) TGA of VNCS

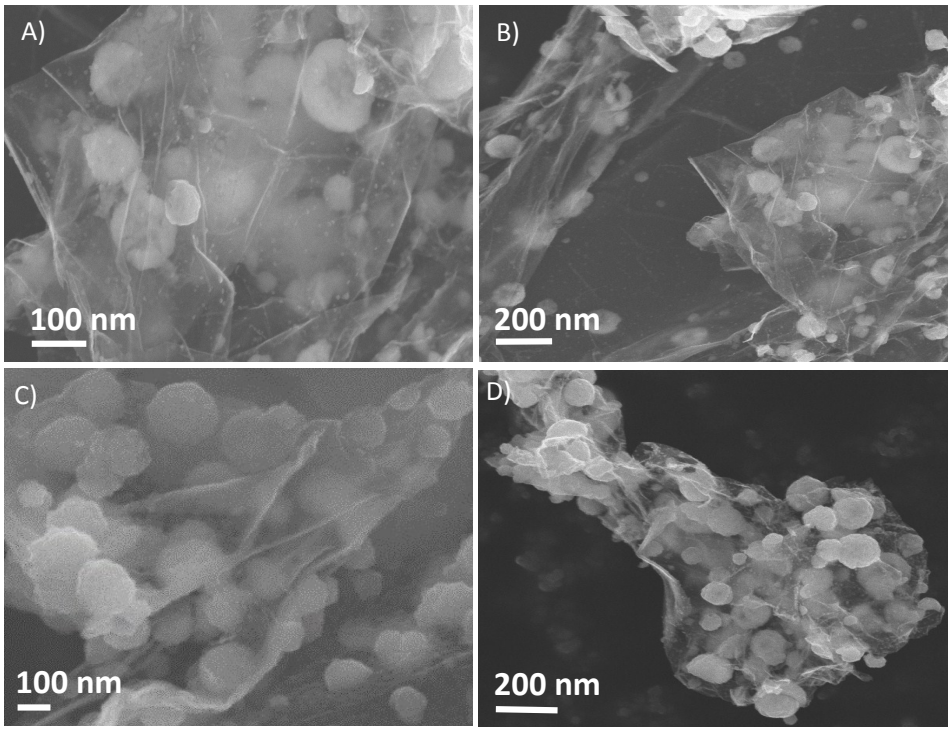

Figure S 2. SEM images showing the graphene wrapping of NCS in GNCS

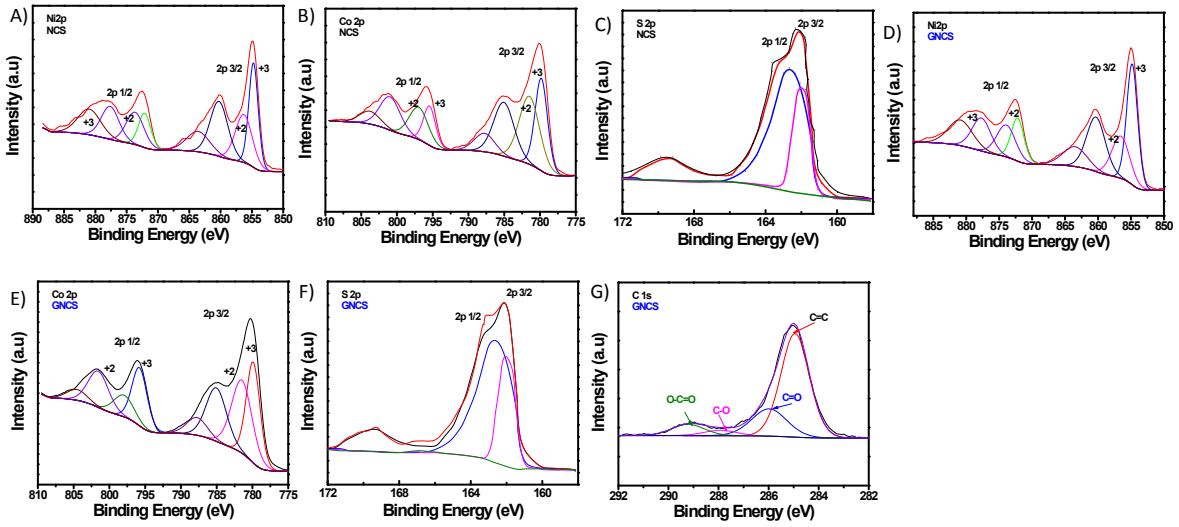

Figure S3. XPS results, A-C) Ni 2p, Co 2p and S2p XPS spectra, respectively for NCS sample, and D-G) Ni 2p, Co 2p, S2p and C 1s XPS spectra, respectively for GNCS

Sample	Peak	BE (eV)	FWHM (eV)	Area (P) CPS (eV)	Atomic ratio (%)
NCS	Ni 2p	854.84	2.38	105871.61	14.002
	Co 2p	780.28	3.65	205211.37	28.432
	S 2p	163.2	2.08	68967.12	57.580
GNCS	Ni 2p	854.88	2.44	200901.38	9.528

	Co 2p	780.25	3.61	392198.45	19.542
	S 2p	162.18	2.04	128769.93	38.792
	C1S	284.88	1.35	52742.86	32.136
VNCS	Ni 2p	854.05	2.31	56626.06	11.106
	Co 2p	779.58	3.53	106986.08	21.978
	S 2p	162.05	2.01	36049.18	44.733
	C1S	284.62	1.37	13103.64	21.745
	V 2p	516.40	1.21	1945.99	0.443

Table S 1. Detailed information about peaks of different elements in the three materials

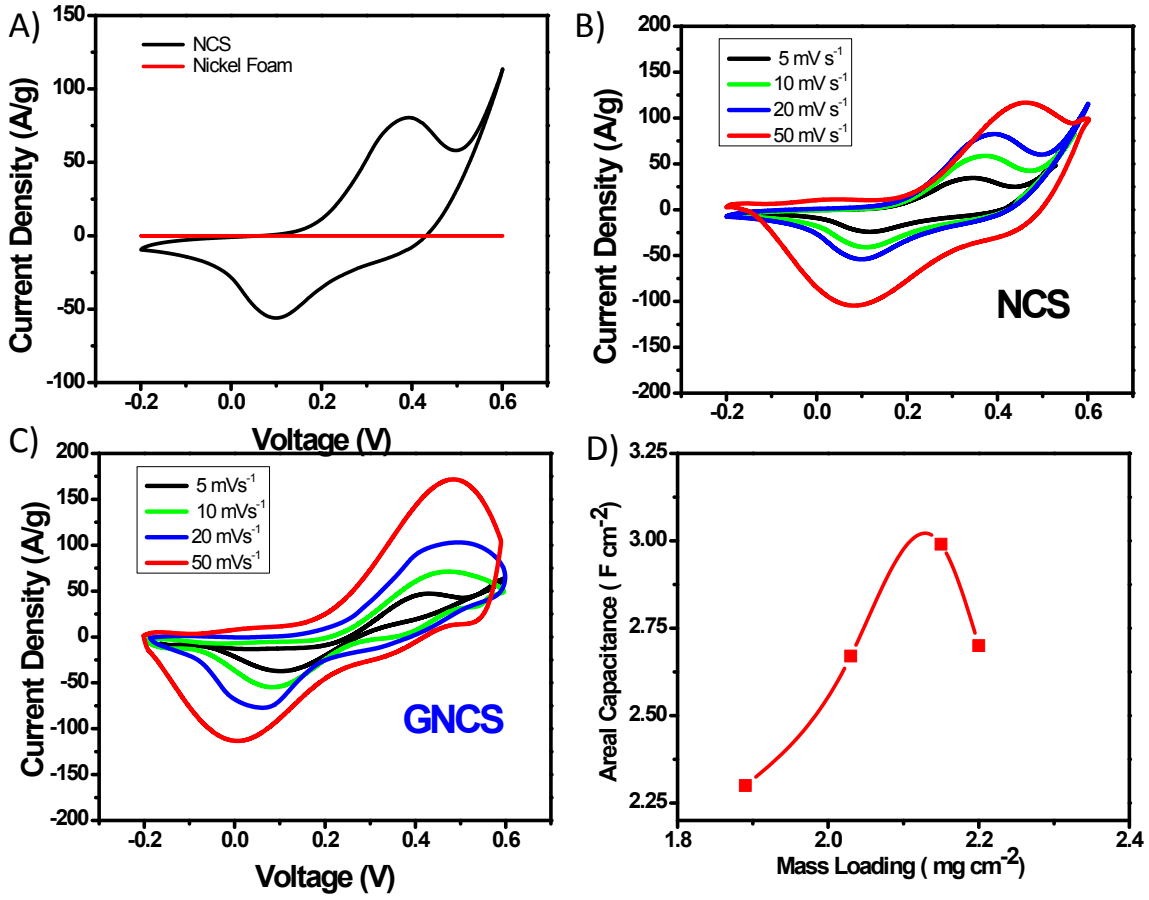

Figure S4. A) CV test of the nickel foam compared to NCS, B-C) CV test of NCS and GNCS at different scan rates, and D) Areal capacitance variation with mass loading of VNCS

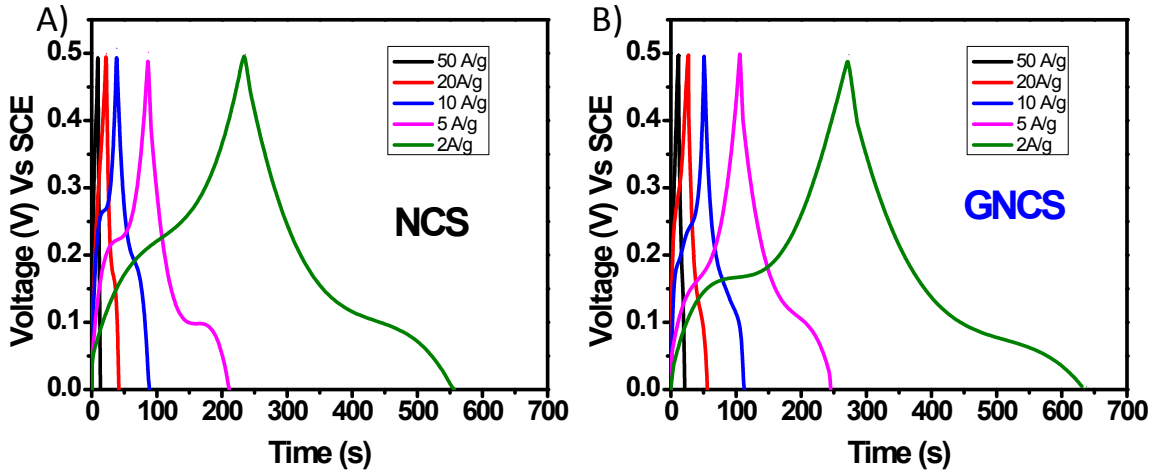

Figure S5. CD results of NCS and GNCS at different current densities

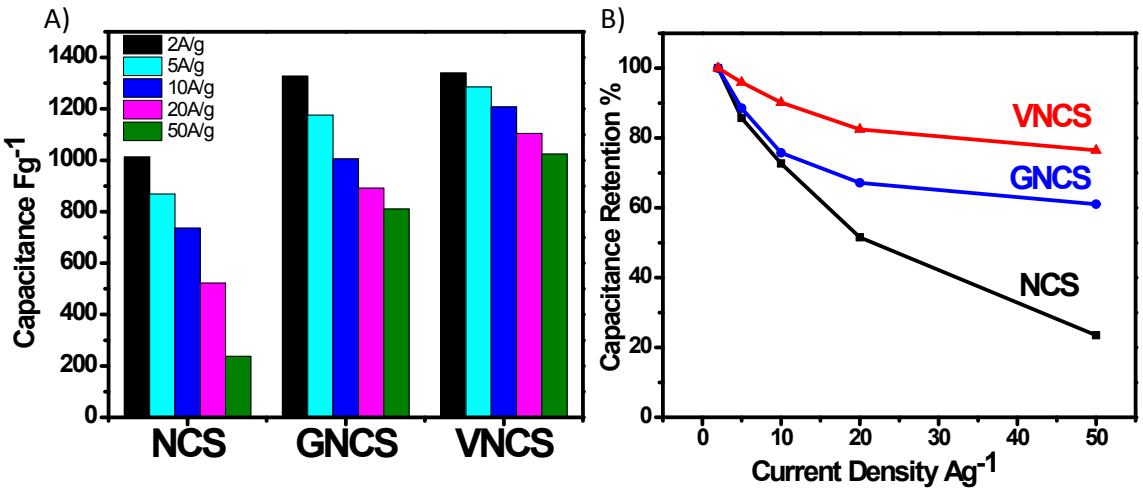

Figure S6. A) Specific capacitance values of all samples at different current rates, and B) Capacitance retention of all samples at all current densities.

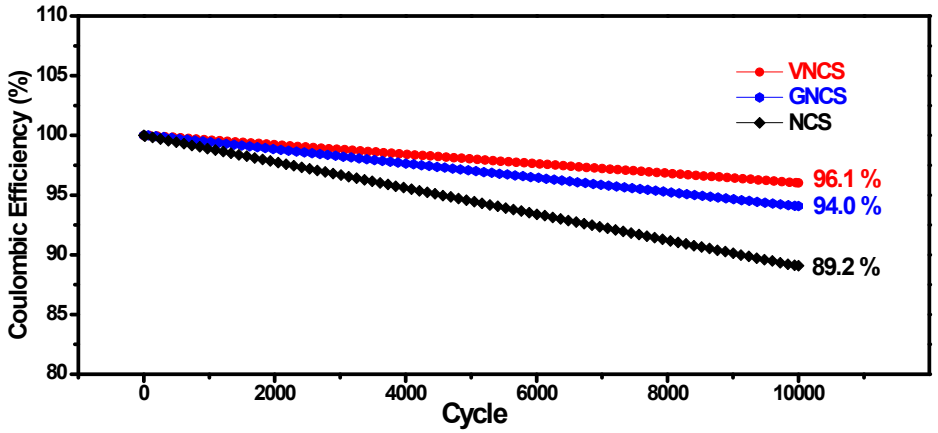

Figure S 7. Columbic efficiency throughout the testing cycles

Ref.	Material	Loading mg.cm^{-2}	C*s* @ 2Ag^{-1} (Fg^{-1})	Capacitance retention (%)		Long cycling (Cycles @ current density)	Capacitance at Cycle # 1 (Fg^{-1})	Reported C*apacitance* retention (% @ number of cycles)	C*s* Retention at 10000 cycles (%)
				20 Ag^{-1}	50 Ag^{-1}				
This Work	**V-Modified $NiCo_2S_4$ /Graphene**	**2.03-2.25**	**1339**	**82**	**76.5**	**10000 @ 10A/g**	**1160.6**	**90.5 @10000 cycles**	**90.5**
(Ref)[1]	$NiCo_2S_4$ ultrathin Nano sheets/Graphene	Not reported	1451 @ 3A g^{-1}	52.4	Not reported	2000@ 5A g^{-1}	1161	95.4 @ 2000 cycles	Not reported
(Ref)[2]	$NiCo_2S_4$ Nano sheets/Ultrathin	4	1304	85.6	Not reported	6000@8 Ag^{-1}	1248	~ 81 @6000 cycles	Not reported
(Ref)[3]	$NiCo_2S_4$ / Graphene/MoS2	5	1270@ 1Ag^{-1}	45	Not reported	4000@ 5Ag^{-1}	1002	92 @ 4000	Not reported
(Ref)[4]	$NiCo_2S_4$ NS/NCF	2.3	1231	71	Not reported	2000@ 10A g^{-1}	1025	90.4 @200	No reported
(Ref)[5]	(3D) $Ni_xCo_{1-x}S_2$/graphene composite hydrogels	5	1166 @ 1Ag^{-1}	48	Not reported	1000@ 5 A g^{-1}	1084	69.4 @ 1000 cycles	Not reported
(Ref)[6]	$NiCo_2S_4$ urchin-like	2-3	1149 @1 Ag-1	77.3	66.2	5000@ 20 Ag^{-1}	888	91.4 @ 5000	Not reported
(Ref)[7]	$NiCo_2S_4$ porous nanotubes	4-6	1093 @ 0.2 Ag^{-1}	Not reported	Not reported	1000@ 1 Ag^{-1}	933	63 @ 1000 cycle	Not reported
(Ref)[8]	$NiCo_2S_4$ /ball-in-ball hollow spheres	5	1036 @ 1 Ag^{-1}	68.1	Not Reported	2000@ 5Ag^{-1}	892	87 @ 2000 cycles	Not reported
(Ref)[9]	$Ni_xCo_{3-x}S_4$ Hollow Nano prisms	1.0	895.2 @ 1Ag^{-1}	65.3	Not reported	1500@ 5 Ag^{-1}	782	85.7	No reported
(Ref)[10]	$NiCo_2S_4$ nanotubes/binder free	4.2	738 @ 2 Ag^{-1}	73 @ 32 Ag^{-1}	Not reported	4000@ 8 Ag^{-1}	738	93.4 @ 4000 cycles	Note reported
(Ref)[11]	$NiCo_2S_4$ Nanoplates/ Hollow Hexagonal	Not reported	437	52.8	Not reported	1000@ 2Ag^{-1}	388	63 @ 1000 cycles	Not reported

Table S2. Comparison between our work and recent reports

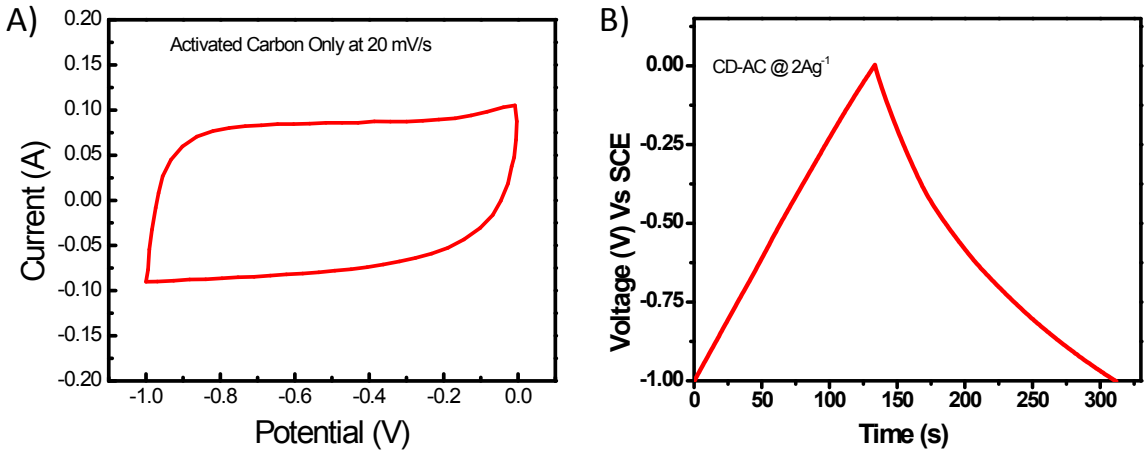

Figure S 8 A) CV, and B) Charge-discharge tests of tests of AC/G electrode

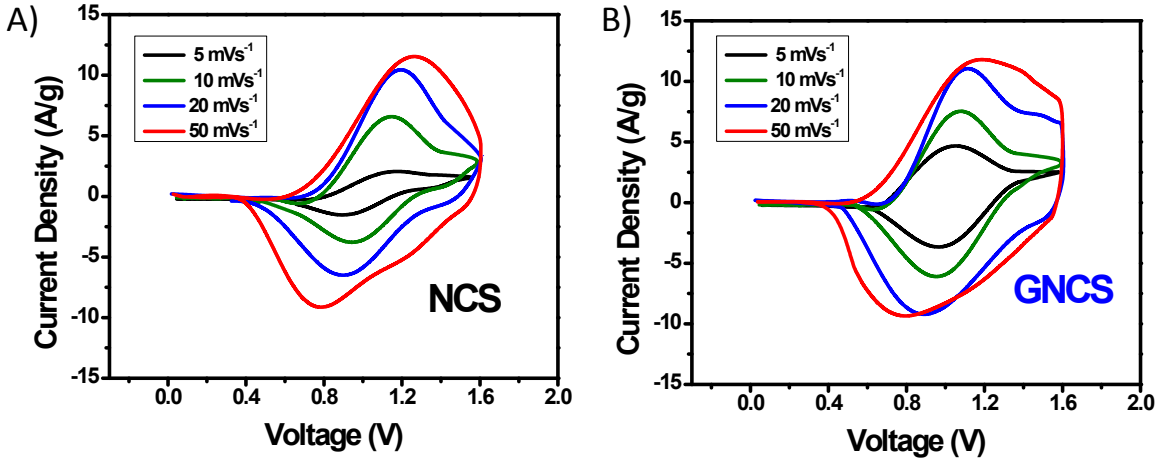

Figure S 9 CV test at different scan rates of A) NCS samples, and B) GNCS sample

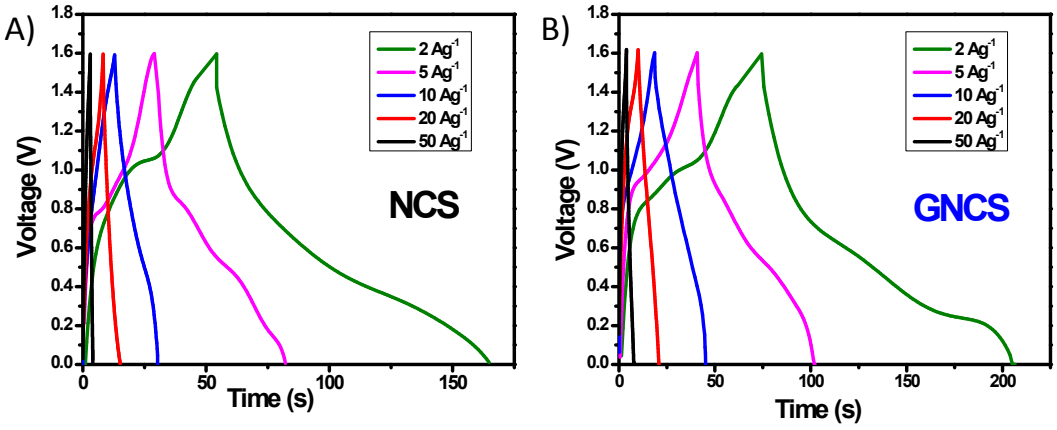

Figure S 10 Charge-Discharge at different current densities of A) P HSC, and B) G HSC

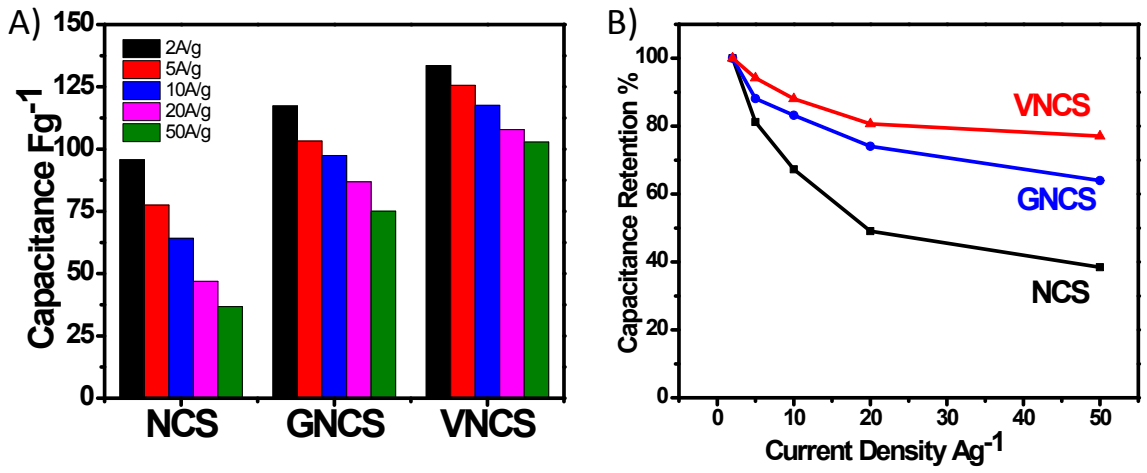

Figure S 11. A) Capcitance values of all samples at different current densities, and B) Capacitance retention of all samples comapred to the capacitance value of each sampel at 2 Ag^{-1}

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