Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supplementary file

Insights on electrochemical capacitor performance of transition metal-vertical graphene nanosheets hybrid electrodes

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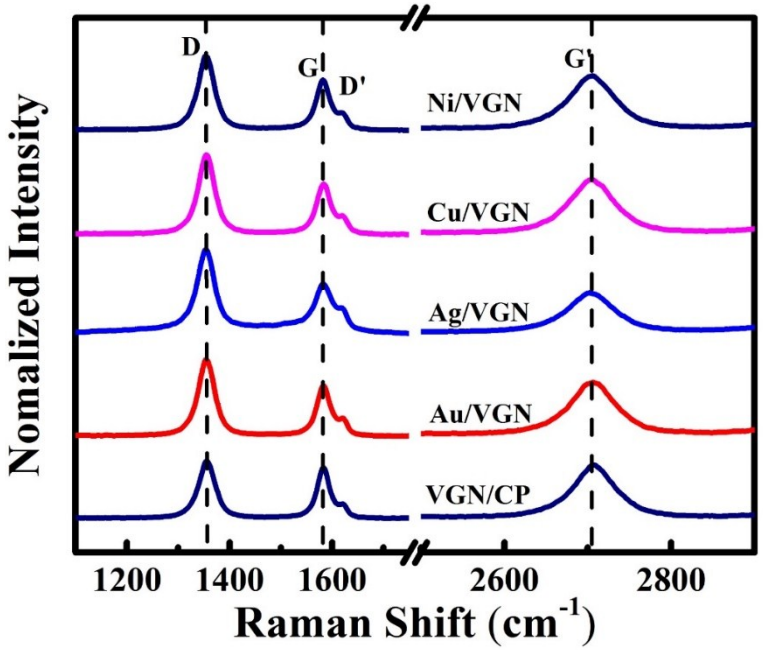

Figure S1: Raman spectra as-grown and metal decorated VGN.

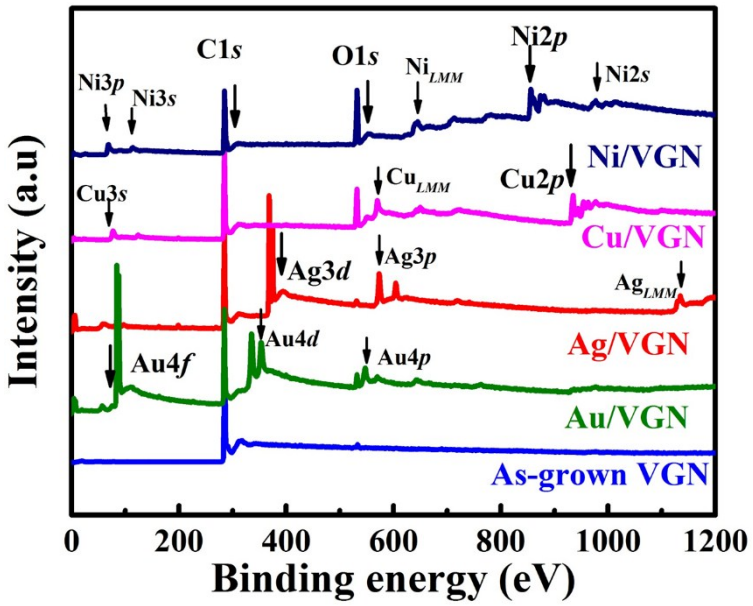

Figure S2. Full survey XPS spectra of as-grown and metal decorated VGN.

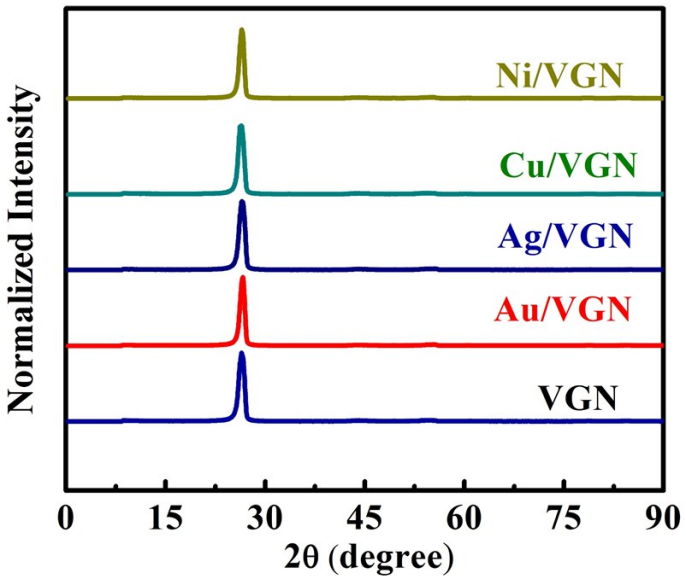

Figure S3. XRD of as-grown and metal decorated VGN.

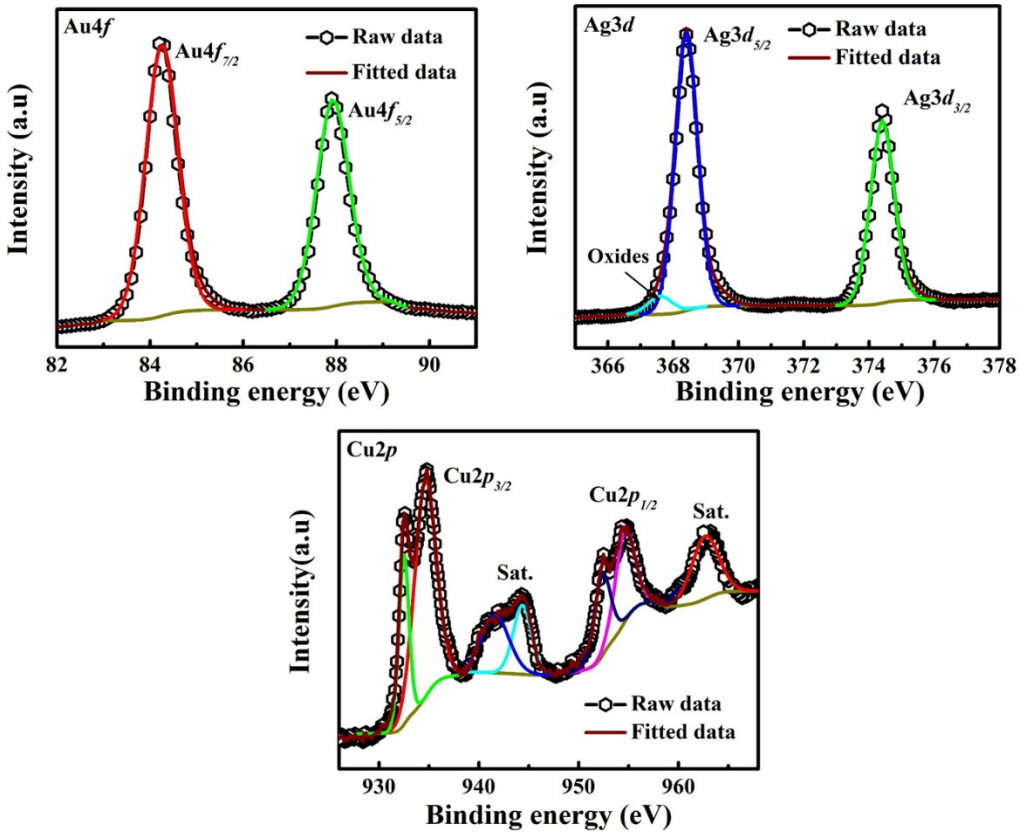

Figure S4: XPS spectra of Au4*f* , Ag3*d* and Cu2*p*.

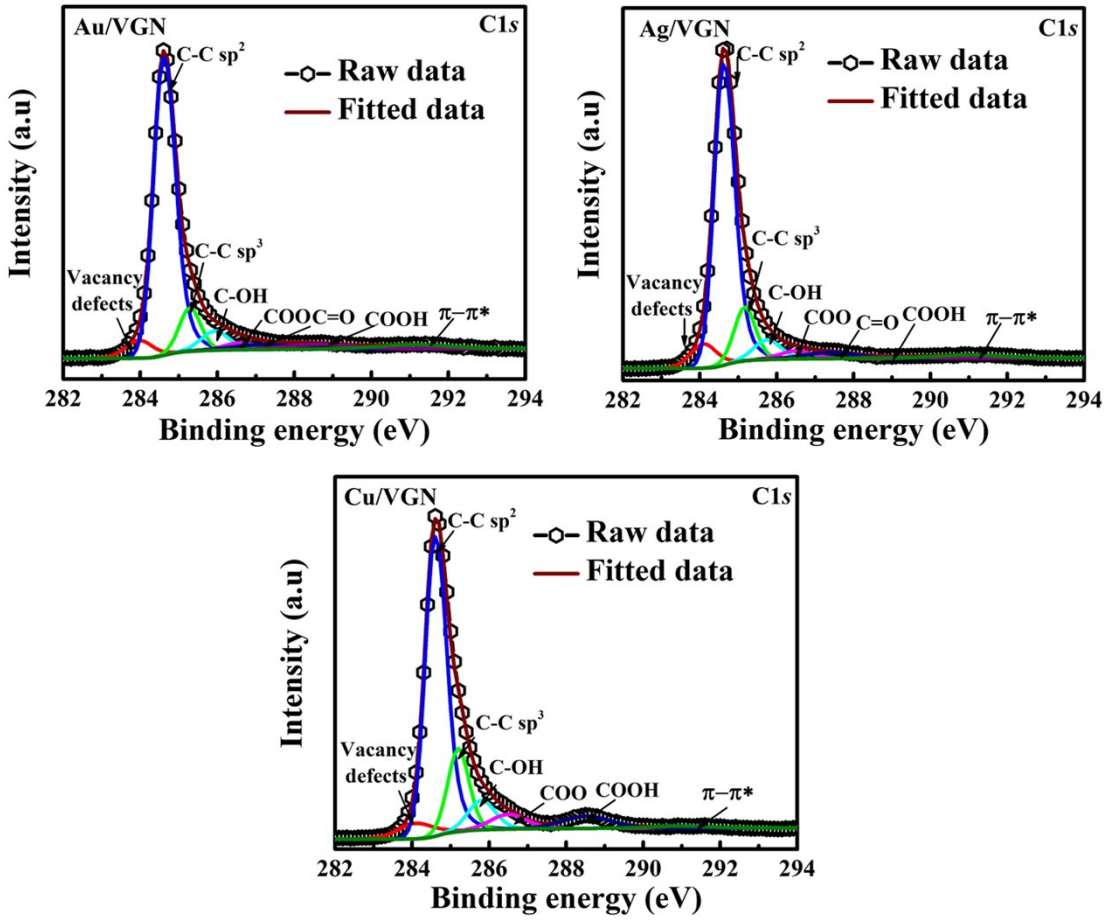

Figure S5: C1*s* spectra of Au, Ag and Cu decorated VGN

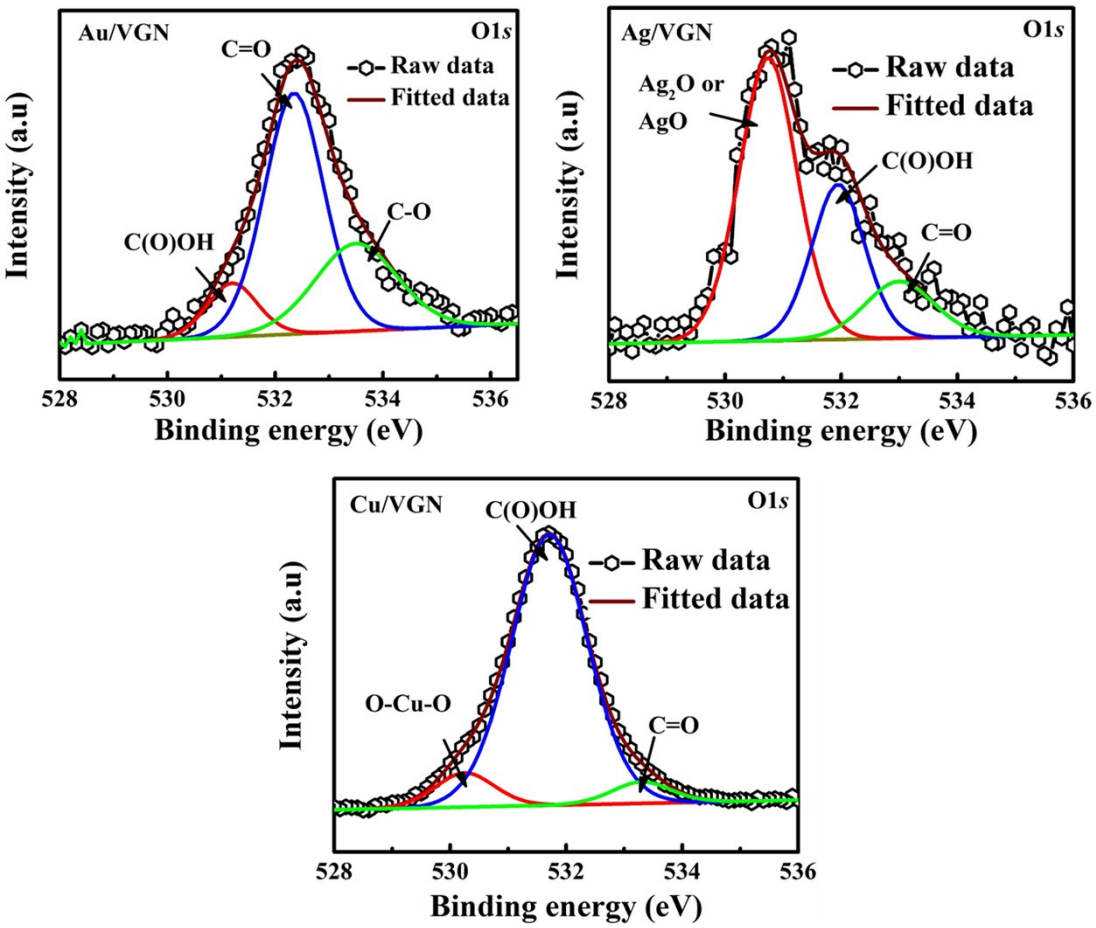

Figure S6: O1*s* spectra of Au, Ag and Cu decorated VGN

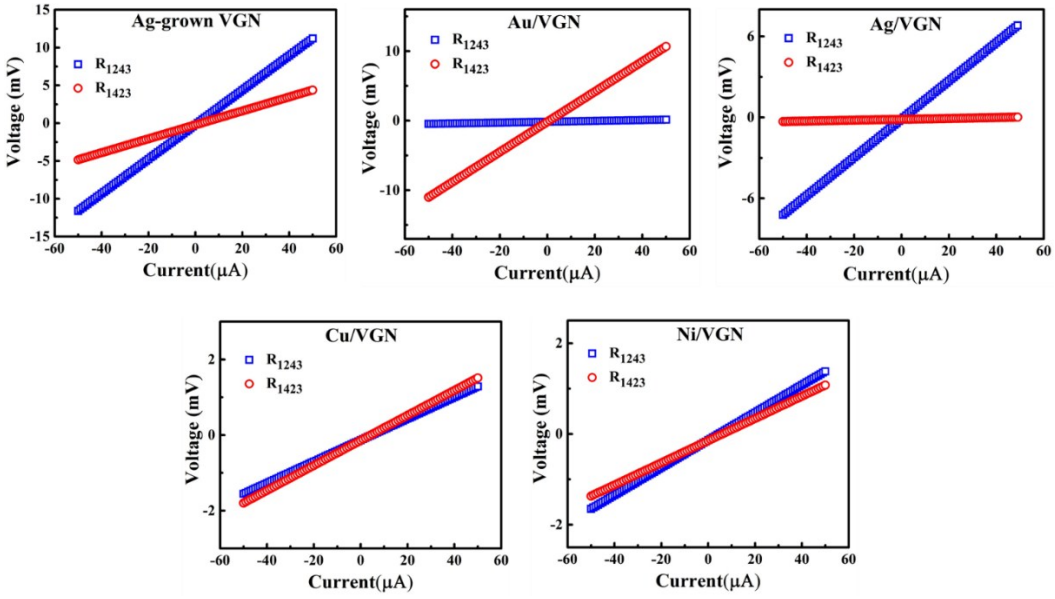

Figure S7: I-V relationship of as-grown and metal decorated (Au, Ag,Cu and Ni) VGN.

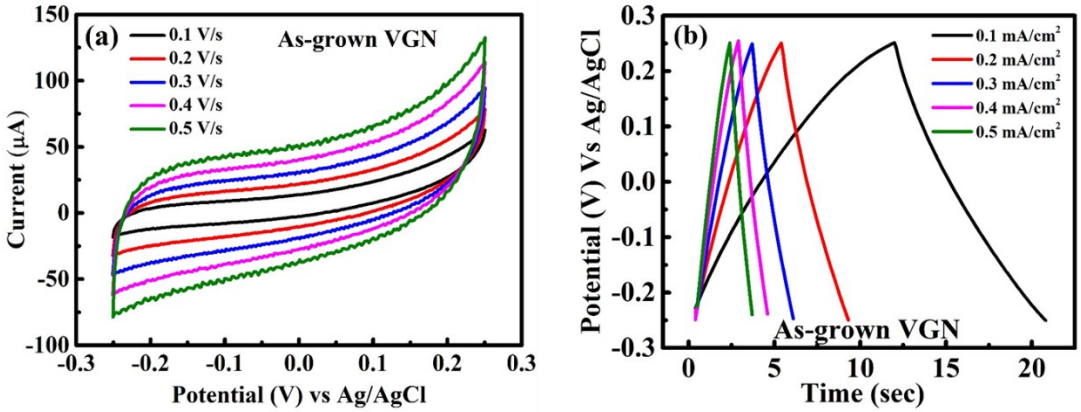

Figure S8: Cyclic voltammogram (CV) and charging-discharging (CD) for as-grown VGN.

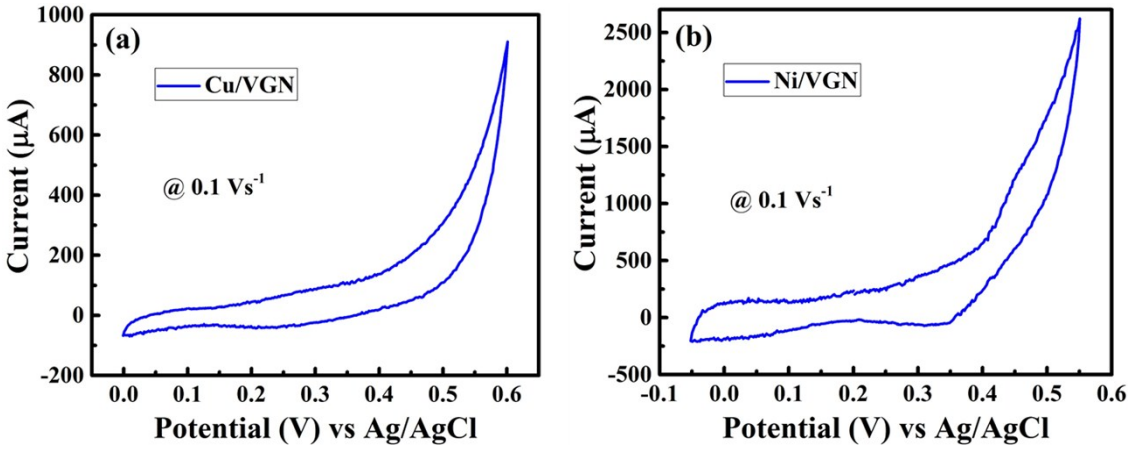

Figure S9: Cyclic voltammogram of Cu and Ni decorated VGN in extented potential window, respectively.

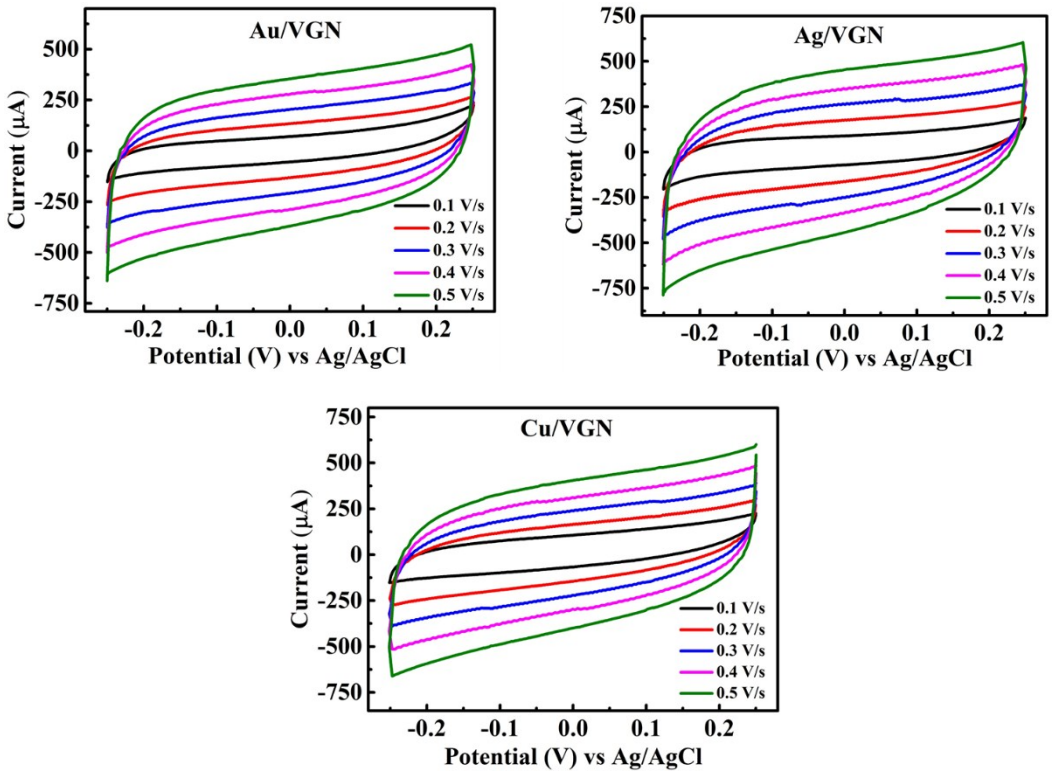

Figure S10: Cyclic voltammogram of Au, Ag and Cu decorated VGN respectively.

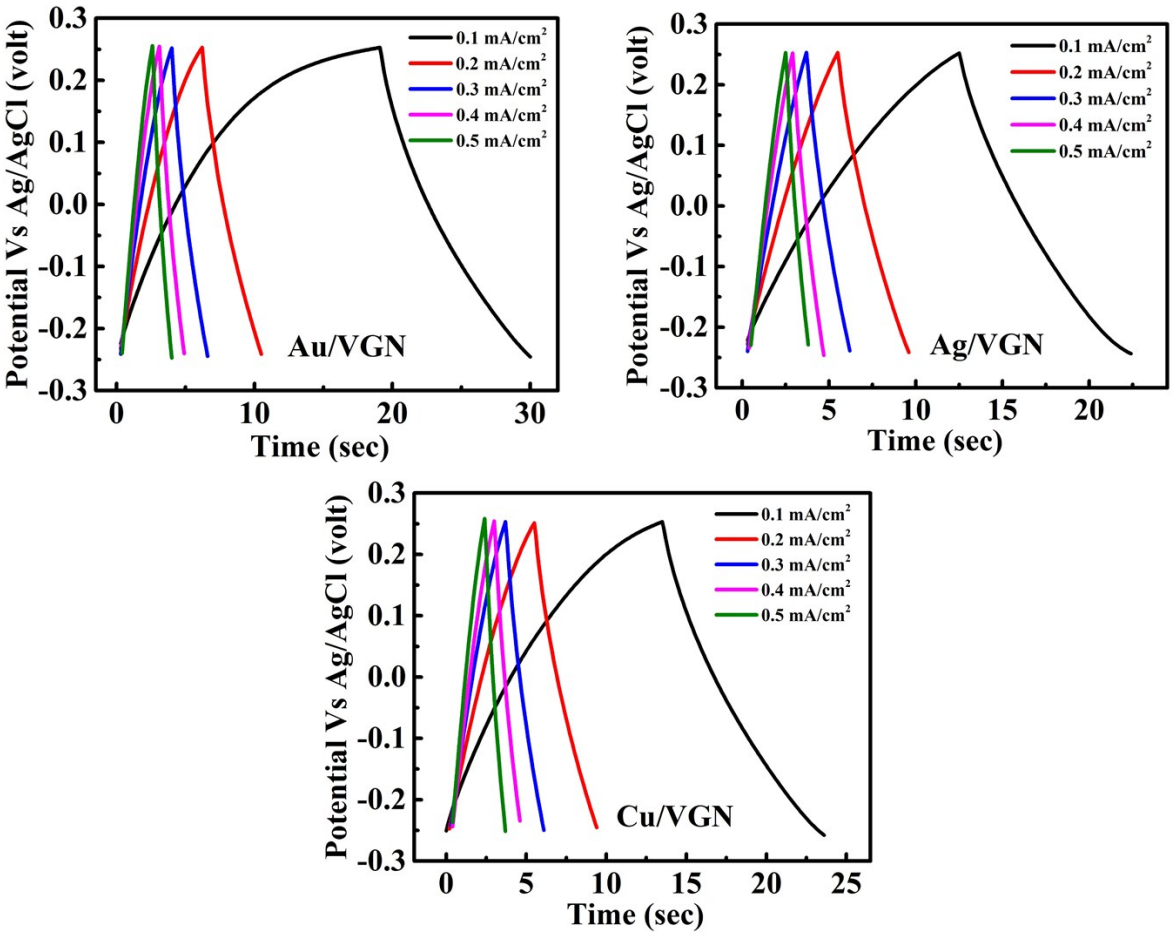

Figure S11: Charging-discharging for Au, Ag and Cu decorated VGN respectively.

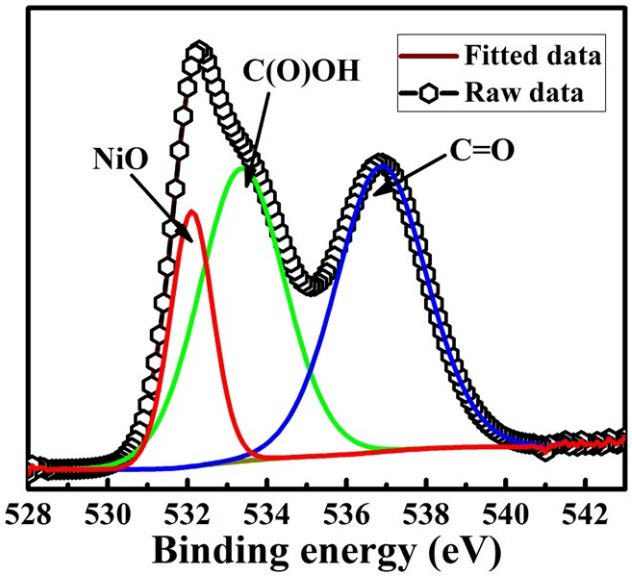

Figure S12: O1s spectra of Ni decorated VGN after the electrochemical testing.

Table S1: Electrochemical capacitance comparison of carbon nanostructure/NiO hybrid electrodes.

Materials	**Capacitance**	**Capacitance measurement at**	**Electrolyte**	**References**
NiO	80 F/g	10 mA/cm2	6M KOH	[1]
NiO nanoparticle	97 F/g	0.1 A/g	1M KOH	[2]
NiO nanosheet	81.6 F/g	0.5 A/g	3M KOH	[3]
CNT/NiO nanoflower	120 F/g	10 mV/s	1M Na_2SO_4	[4]
VGN/NiO nanoparticle	121.6 F/g	100 mV/s	1M KOH	This work
Graphene/Ni nanocomposite	144 F/g	10 A/g	1M KOH	[5]

Adatom	Sites	$-E_{ads}$ (eV)	$-E_{ads}^{vdw}$ (eV)	d_{TM-C} (Å)	d_{TM-C} (Å)
Ni	**H**	1.432	1.738	2.117	2.112
	T	1.137	1.383	1.856	1.856
	B	1.218	1.477	1.939	1.939
Cu	**H**	0.178	0.438	2.391	2.372
	T	0.327	0.555	2.079	2.084
	B	0.334	0.572	2.167	2.167
Ag	**H**	0.091	0.354	4.268	3.835
	T	0.098	0.361	4.072	3.529
	B	0.096	0.360	3.972	3.591
Au	**H**	0.296	0.583	4.165	4.015
	T	0.308	0.591	4.128	3.807
	B	0.307	0.589	4.176	3.879

Table S2: Adsorption energy for different sites of metal decorated adatoms on graphene.

References:

1. S. R. Gawali, D. P. Dubal, V. G. Deonikar, S. S. Patil, S. D. Patil, P. Gomez-Romero, D. R. Patil and J. Pant, ChemistrySelect, 2016, 1, 3471-3478.

2. N. Duraisamy, A. Numan, S. O. Fatin, K. Ramesh and S. Ramesh, J. Colloid Interface Sci., 2016, 471, 136-144.

3. H. Xiao, S. Yao, H. Liu, F. Qu, X. Zhang and X. Wu, Prog. Nat. Sci., 2016, 26, 271-275.

4. D. Banerjee, U. K. Ghorai, N. S. Das, B. Das, S. Thakur and K. K. Chattopadhyay, ACS Omega, 2018, 3, 6311-6320.

5. N. A. M. Zaid and N. H. Idris, Sci. Rep., 2016, 6, 32082.