Electronic Supplementary Material (ESI) for RSC Advances.

Microwave-assisted synthesis of voids induced graphene-wrapped nickel-oxide hybrids for supercapacitor application

Rajesh Kumar,*[a] Rajesh Kumar Singh,*[b] Raluca Savu,[a] Pawan Kumar Dubey,[c] Pradip Kumar,[d] and Stanislav A. Moshkalev [a]

[a.] *Centre for Semiconductor Components, State University of Campinas (UNICAMP), 13083-870 Campinas, Sao Paulo, Brazil. E-mail: rajeshbhu1@gmail.com*
[b.] *Department of Physics, Indian Institute of Technology (Banaras Hindu University), Varanasi 221005, India. E-mail: rksbhu@gmail.com*
[c.] *Nanotechnology Application Centre, University of Allahabad, Allahabad 211002, India*
[d.] *Centre for Materials Architecturing, Korea Institute of Science and Technology, Hwarangno 14-gil 5, Seongbuk-gu, Seoul 136-791, Republic of Korea*

1. SEM of VGWN hybrids

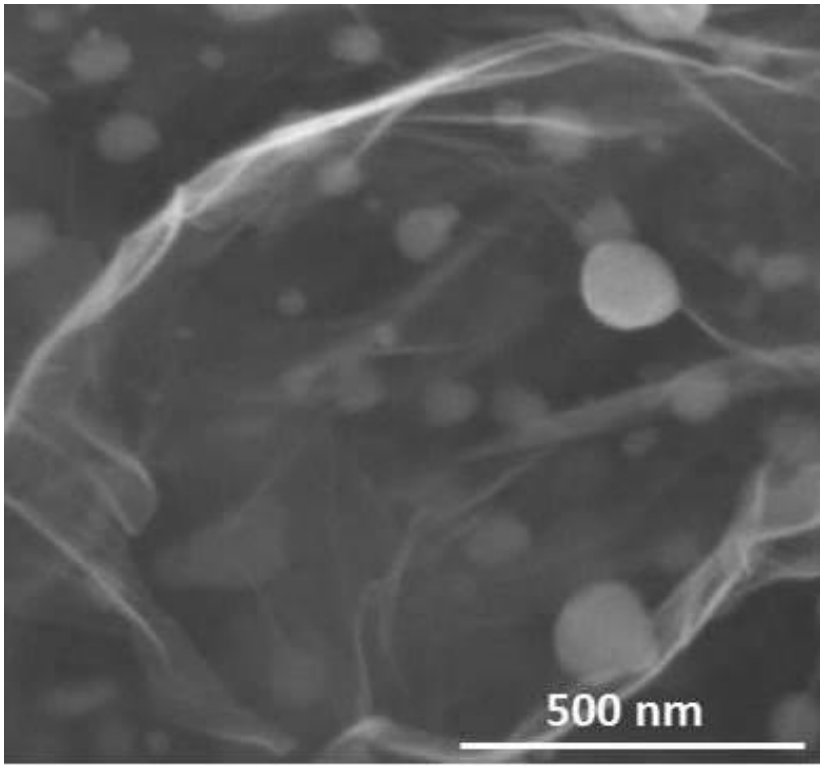

Fig. S1 Magnified view of graphene wrapped NiO nanoparticles and voids.

2. Structural defect on surface

Fig. S2 SEM micrograph of VGWN hybrids show the structural defect on the surfaces after long time microwave irradiation (4 minutes).

Table S1. Comparison of electrochemical performance of NiO-graphene hybrids based supercapacitors

S. No	Hybrids/ Nanostructures	Synthesis method	Sp. capacitance (current density/scan rate)	Electrode system (electrolyte)	Cycling response/ Retention (cycle, current density or scan rate)	Ref.
1.	NiO-sulfonated graphene	Thermal treatment	307 F g-1 (5.0 A g^{-1})	3 electrode cell (6 M KOH)	90% retention after (1000, 5 A g^{-1})	47
2.	3D hierarchical graphene-NiO Structure	Pyrolysis process	517.8 F g^{-1} (2 A g^{-1})	3 electrode cell (6 M KOH)	decreases from 550 to 504 F g^{-1} after (2000, 1 A g^{-1})	48
3.	Ni based compound incorporated with graphene sheets	Annealing process	2394 F g^{-1} (1 A g^{-1})	3 electrode system (2 M KOH)	78% of the value retained after (5000, 1 A g^{-1})	49
4.	3D graphene/nickel oxide nanoparticles composites	High-temperature treatment	1328 F g^{-1} (1 A g^{-1})	3 electrode system (2 M KOH)	87% capacitance after (2000, 2 A g^{-1})	50
5.	3D graphene/$Ni(OH)_2$ composite	Electrochemical reduction approach	183.1 F g1 (at 0.5 A g^{-1})	2 electrode system (2 M KOH)	8.8% capacity deterioration after (1000, 1 A g^{-1})	51
6.	$Ni(OH)_2$-graphene sheet-carbon nanotube composite	Solvothermal method	1170.38 F g^{-1} (0.2 A g^{-1})	3 electrode system (6 M KOH)	capacitance decreased 20.03% of initial after (1000, 1.2 A g^{-1})	52

7.	3D-$Ni(OH)_2$ nanoflakes/graphene/ nickel foam	Annealing process	2161 F g^{-1} (3 A g^{-1})	3 electrode cell, (0.1 M $Ni(NO_3)_2$)	51% capacitance retention after (500, 60 A g^{-1})	53
8.	Ni/reduced graphene oxide composites	Solvothermal Synthesis	547.3 F g^{-1} (1 A g^{-1})	half-cell setup (2 M KOH)	81% of initial value (1000, 1 A g^{-1})	54
9.	Graphene nanosheets/ NiO composite	Microwave-assisted method	502 F g^{-1} (3.7 A g^{-1})	3 electrode cell (6 M KOH)	90% specific capacitance after (1000, 0.6 A g^{-1})	55
10.	Reduced graphene oxide-nickel oxide composite	Annealing process	356 F g^{-1} (40 mV s^{-1})	3 electrode cell (6 M KOH)	Columbic efficiency remains 96% (1000, 2 A g^{-1})	56
11.	Mesoporous nickel oxide/reduced graphene oxide composites	Hydrothermal synthesis	520.8 F g^{-1} (10 mV/s)	3 electrode system (6 M KOH)	94.9% retention after (5000, 10 mV/s)	57
12.	NiO nanoflakes/graphene nanocomposite	Hydrothermal method	240 F g-1 (5 A g-1)	3 electrode system (6 M KOH)	superior stability of 100-120% retention of after (1500, 5 A g^{-1})	58
13.	Graphene sheet/porous NiO hybrid film	Electrophoretic and chemical bath deposition	400 F g^{-1} (2 A g^{-1})	3 electrode cell (1 M KOH)	94% retention after (2000, 2 A g^{-1})	59
14.	3D NiO/ultrathin derived graphene hybrid	Nano-casting process	300 F g^{-1} (10 A g^{-1})	3 electrode system (5 M KOH)	90% retention after (500, 10 A g-1)	60
15.	Voids Induced Graphene-Wrapped Nickel-Oxide Hybrids	Microwave Assisted Synthesis	549 F g^{-1} (10 mV s^{-1})	3 electrodes system (5M KOH)	decreases upto ~12% of initial value for the first 115 cycles, after that it shows constant (88%) for long cycling (at 8 A g^{-1})	Our work