Supplementary Material (ESI) for Journal of Materials Chemistry

Mesoporous Nickel/Carbon Nanotube Hybrid Material Prepared by Electroless Deposition

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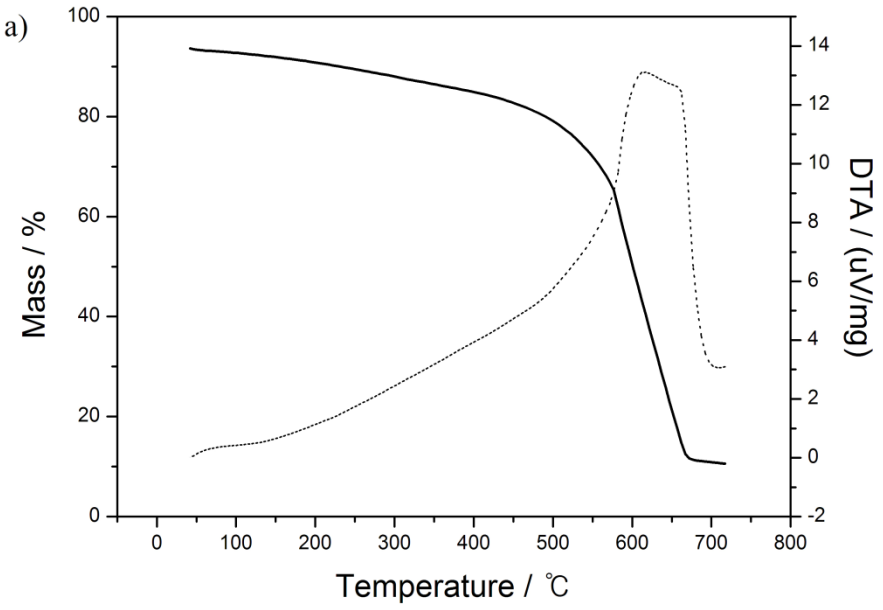
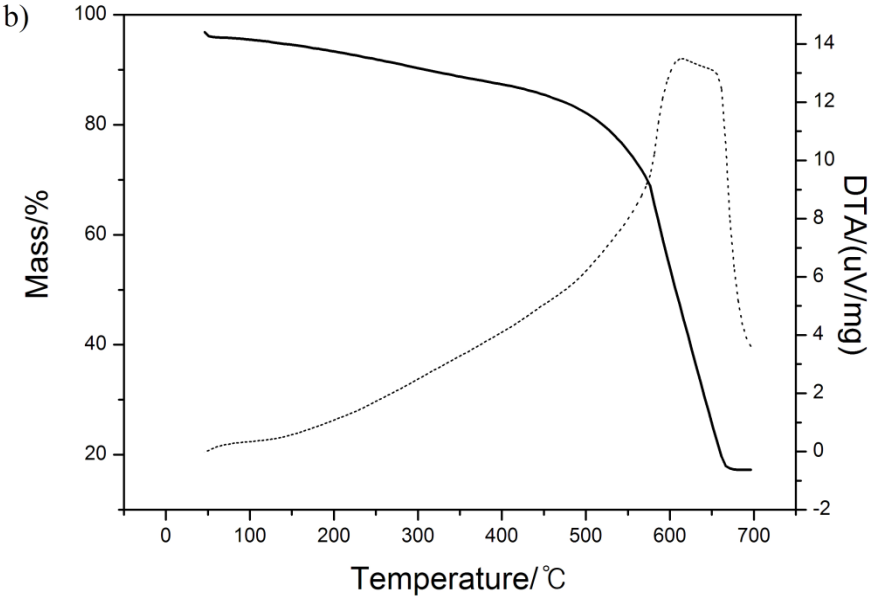
Supporting Information

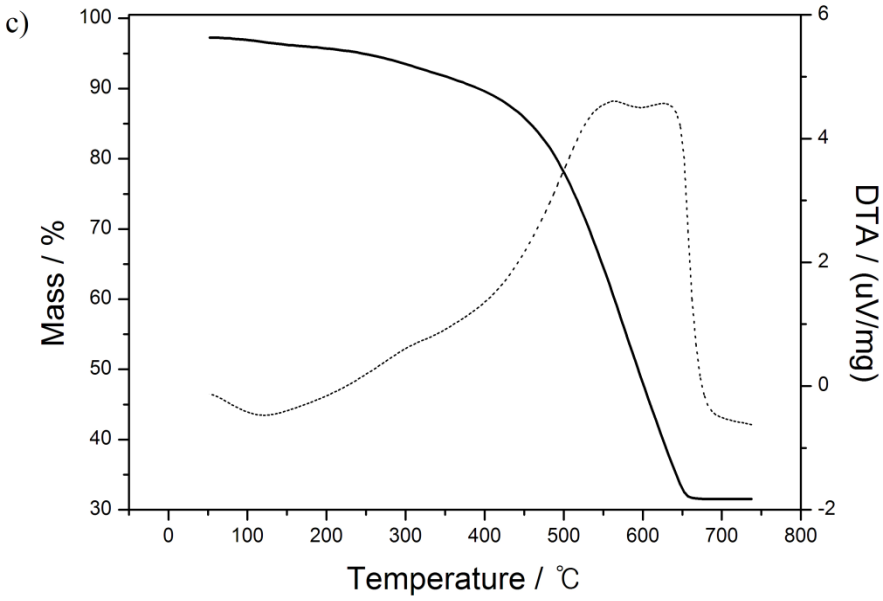
S1. TG-DTA plots for Pd-modified CNTs synthesized with activation times of a) 5min. b) 10min. c) 30min. and d) plot of Pd weight % for Pd-modified CNTs vs. activation time.



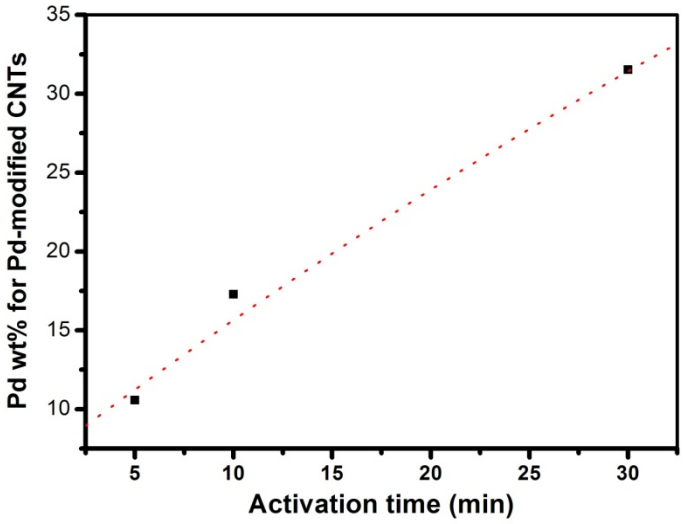
b)



c)



d)



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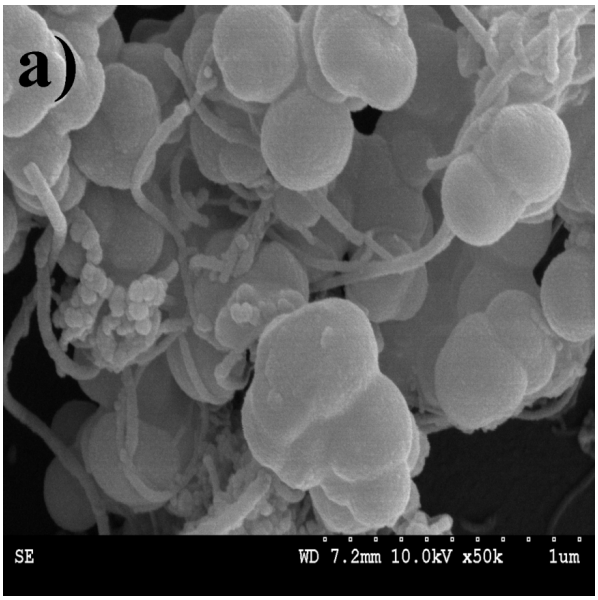
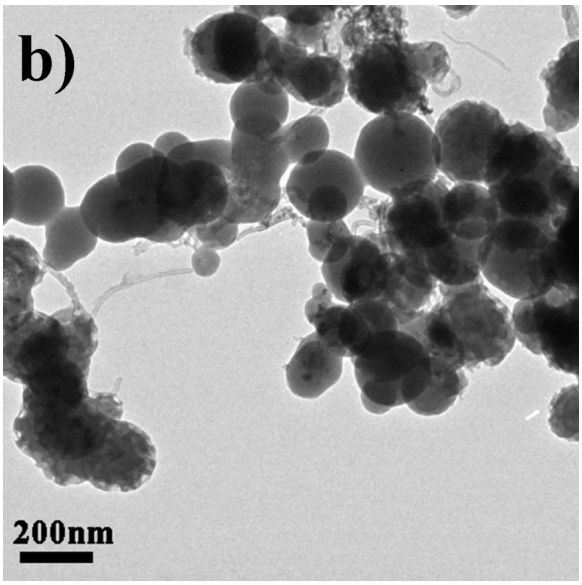
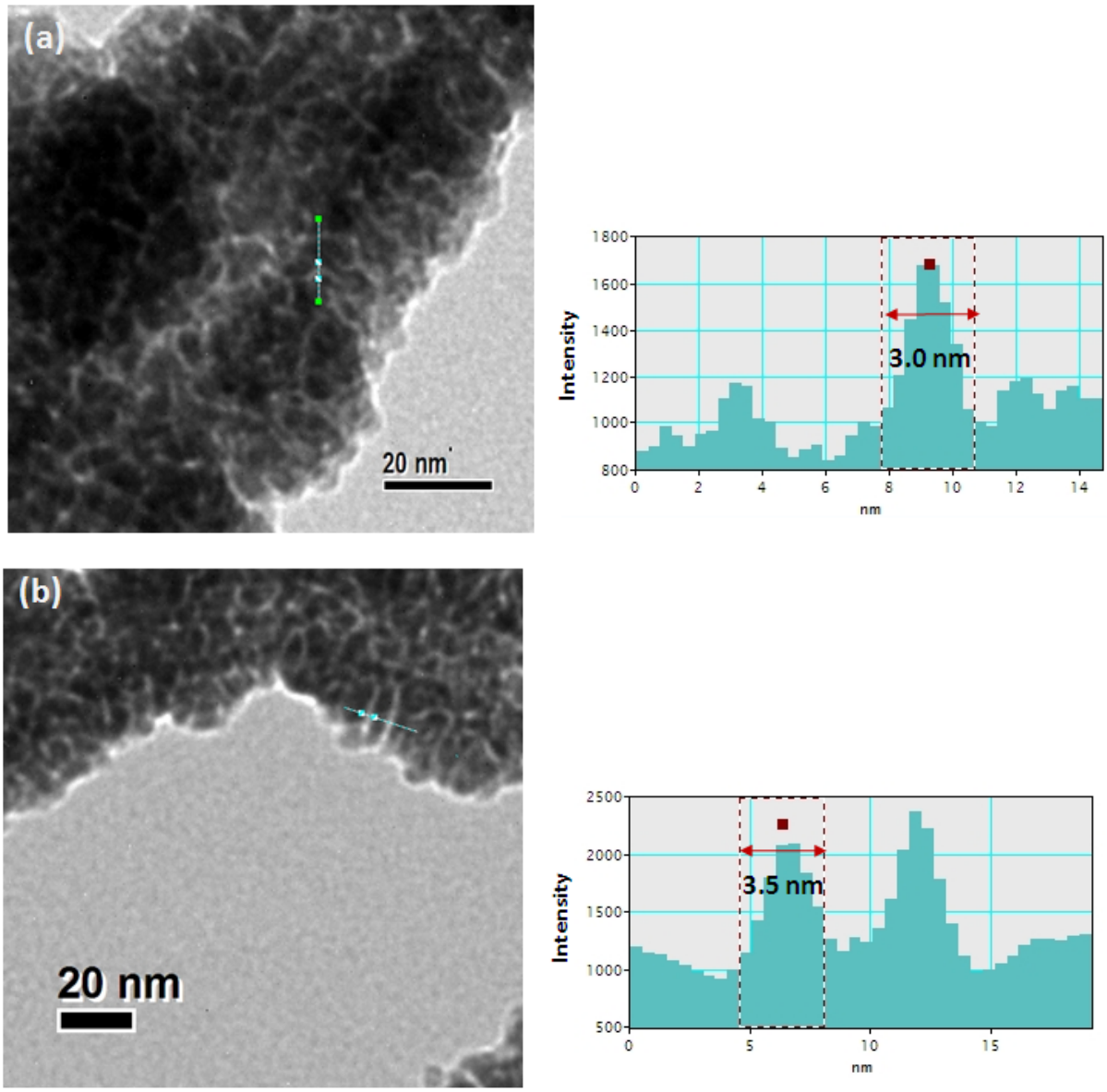
S2. a) FE-SEM and b) TEM images of Ni nanoparticles synthesized through homogeneous nucleation and growth in the solution with Pd catalyst-free CNTs.

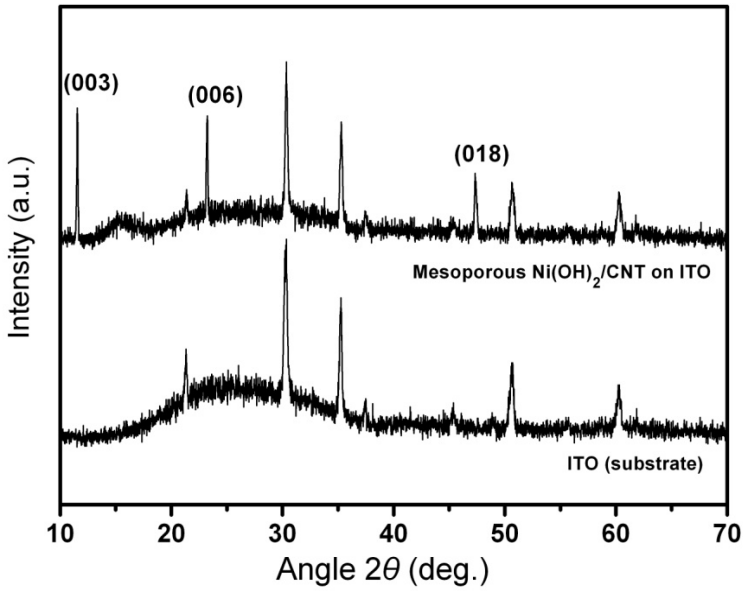




S3. TEM image and direct line scanning analysis profile of the mesoporous Ni/CNT nano-hybrid via LLC templating with pore size of (a) 3.0 nm and (b) 3.5 nm.



S4. XRD patterns of mesoporous $Ni(OH)_2$/CNT film electrodes.



S4 shows the typical XRD patterns of mesoporous $Ni(OH)_2$/CNT film. The XRD patterns of the mesoporous $Ni(OH)_2$/CNT film consists of peaks at 11.5˚(003), 23.2˚(006) and 47.3˚(018). Except the substrate peaks, the XRD result corresponds to the α-nickel hydroxide hydrate (JCPDS no.38-0715).[1]

S5. Electrochemical properties of nickel oxide based electrode materials prepared by various synthesis routes in the literature.

Material	Synthetic method	Specific capacity	Rate capability	Ref
Porous NiO	LLC templating electrodeposition	146 F g^{-1} at scan rate of 10 mV/sec	Decrease of 58 % (from 10 to 100 mV s^{-1})	2
Porous Ni	LLC templating electrodeposition	50 F g^{-1} at scan rate of 50 mV/sec	-	3
Mesostructured $Ni(OH)_2$ film	Micelle template electrochemical deposition	-	-	4
Nanoporous $Ni(OH)_2$ film	LLC templating electrodeposition	578 F g^{-1} at discharging current of 2.5 mA	Decrease of 23% (from 2.5 to 10 mA)	5
Mesoporous NiO film	LLC templating electrodeposition	590 F g^{-1} at discharging current of 2.5 mA	Decrease of 31% (from 2.5 to 10 mA)	6
NiO loaded porous carbon	Impregmation (loading amount of NiO: 1 wt.%)	230 F g^{-1} at discharging current of 3 mA	-	7
NiO loaded activated carbon	Suspending the activated-carbon in a $Ni(NO_3)_2$ solution (loading amount of NiO: 4.3 wt.%)	196 F g^{-1} at discharging current of 10 mA	Decrease of 3% (from 10 to 80 mA)	8
$Ni(OH)_2$/activated carbon composite	Physical mixing	540 F g^{-1} at discharging current of 1 mA	Decrease of 20% (from 1 to 10 mA)	9
$Ni(OH)_2$/activated carbon composite	Chemical precipitation (loading amount of $Ni(OH)_2$: 10wt.%)	260 F g^{-1} at scan rate of 2 mV/sec	Decrease of 14% (from 2 to 8 mV s^{-1})	10
NiO/MWCNT composite	Chemical impregnation (loading amount of	240 F g^{-1} at discharging current of 1mA	-	11

	NiO: 14 mol%)			
$Ni(OH)_2$/MWCNT composite	Hydrothermal synthesis (loading amount of $Ni(OH)_2$: 10 wt.%)	432 F g^{-1} at scan rate of 10 mVs^{-1}	Decrease of 73% (from 10 to 500 mVs^{-1})	12
$Ni(OH)_2$/MWCNT composite	Chemical precipitation (loading amount of $Ni(OH)_2$: 70wt.%)	303 $mAhg^{-1}$ at discharging current of 0.1Ag^{-1}	Decrease of 13% (from 0.1 to 0.4 Ag^{-1})	13
Mesoporous $Ni(OH)_2$/CNT nano-hybrid	Electroless deposition via selective heterogeneous nucleation and growth (loading amount of Ni: 61wt.%)	306 $mAhg^{-1}$ at scan rate of 10 mVs^{-1} (equivalent to a discharging current of 22 Ag^{-1})	Decrease of 20% (from 10 to 100 mVs^{-1})	This study

S5 compares the electrochemical properties of the mesoporous Ni/CNT nano-hybrid in this study with mesoporous NiO, mesoporous $Ni(OH)_2$, NiO/activated carbon composite, $Ni(OH)_2$/activated carbon composite, NiO/CNT composite and $Ni(OH)_2$/CNT composite reported in the literature. Xia et al. reported the specific capacity of 303 mAh g^{-1} for $Ni(OH)_2$ in a $Ni(OH)_2$/CNT nano-composite at 0.1 A g^{-1}, in which $Ni(OH)_2$ nanoparticles were dispersed on the CNTs with a $Ni(OH)_2$ loading of 70 wt.%.[13] Our mesoporous $Ni(OH)_2$/CNT shows the specific capacity of 306 $mAhg^{-1}$ for $Ni(OH)_2$ in the hybrid at much higher charge/discharge rates. It demonstrates that the mesoporous $Ni(OH)_2$/CNT nano-hybrid has a great potential as an electrode materials with excellent high rate capability for high rate battery applications.

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