Electronic Supplementary Information (ESI)

Rusted iron wire waste in to high performance anode (α-Fe_2O_3) for Li-ion battery: An efficient waste management approach

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Table S1: Comparison of Li/α–Fe_2O_3 half-cell results with literature reports.

Morphology	Capacity (Cycle) $mAh\ g^{-1}$	Current rate ($A\ g^{-1}$)	Electrode Composition (AM:SP:B)*	Reference
Interconnected α–Fe_2O_3 NPs	> 1400 (79)	0.1	40:50:10	This work
Interconnected α–Fe_2O_3 NPs	~800 (215)	0.2	60:30:10	This work
Elongated	840 (40)	0.1	70:15:15	17
Hollow Nanofibers	~ 1293 (40)	0.06	30:50:20	21
Nanorods	~ 900 (30)	0.2	60:20:20	22
Discs	~550 (100)	0.1	50:25:25	23
Spindles	911 (50)	0.2	80:10:10	24
Mesoporous	1293 (50)	0.1	50:40:10	30
Spindles	~900 (40)	0.1	30:50:20	39
Nanofibers	~1095 (50)	0.05	70:15:15	41
Cubes	458 (100) (hollow) 177 (100) (solid)	0.1	70:20:10	42
Nanospindles Hollow	456 (100)	0.1	75:15:10	43
Nanorods array	562 (50)	0.2	75:15:10	44
Nanotubes	510 (50)	0.1	85:10:5	45
Spheres	863 (50)	0.1	---	46
Spheres	710 (100) 340 (100)	0.2	70:20:10	47
Melon like	662 (100)	0.2	70:20:10	48

AM: Active material, SP: Carbon Black (Super-P), B: Binder

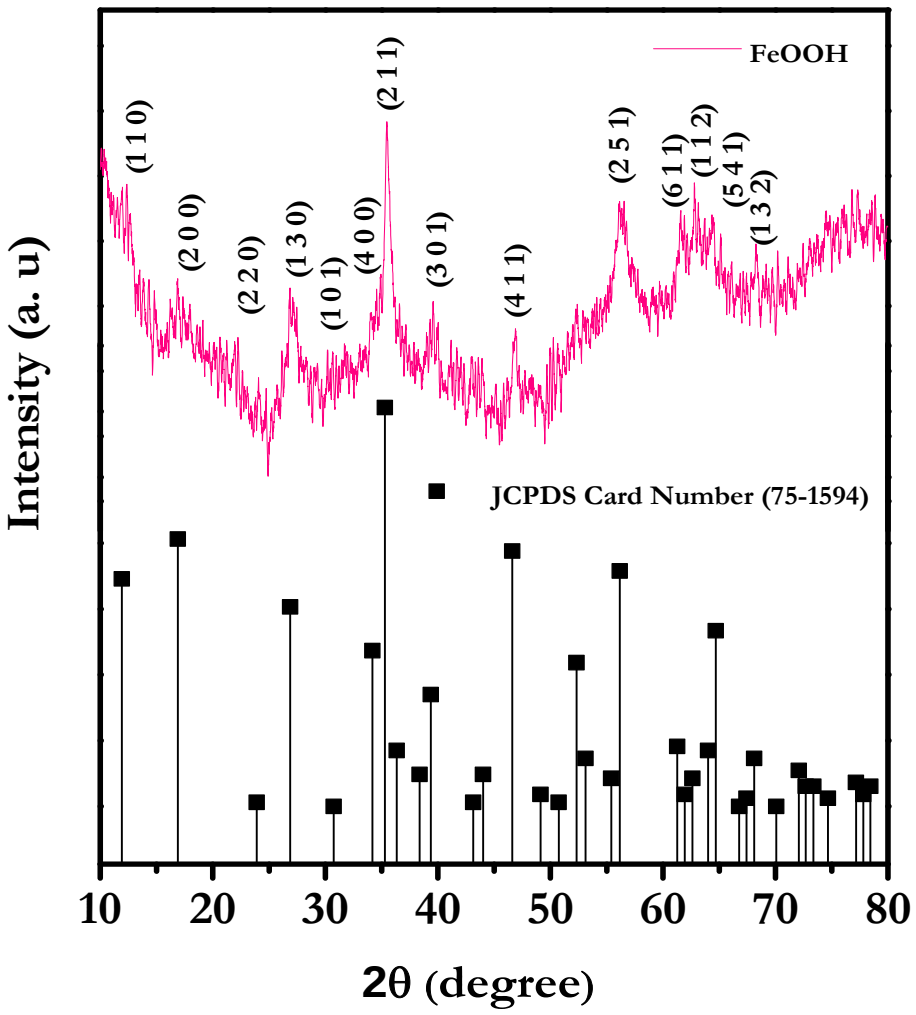

Figure S1: X-ray diffraction plot for intermediate FeOOH.

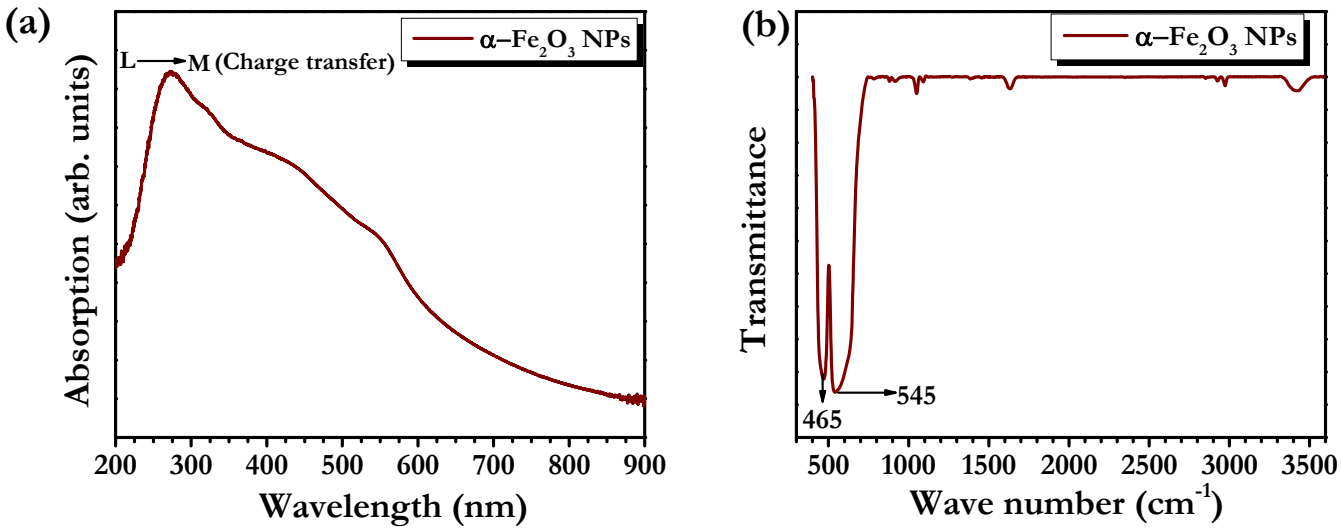

Figure S2: (a) UV-visible absorption plot and (b) Raman plot for α–Fe_2O_3 NPs.

ICP-AES analysis for rust scratched from rusted wires (precursor) and final α–Fe_2O_3 NPs.

Sample preparation for ICP-AES analysis

A particular amount of rust (scratched from rusted wire) is dissolved in (3 mL) aqua regia and 1 mL conc. H_2O_2 followed by microwave digestion treatment. Then, the sample was collected by diluting the solution up to 50 mL with D. I. water that was named as the stock solution. This solution was used to detect possible metal impurities such as Cu, Al, Cr and Ni. However, for the detection of Fe the stock solution was further diluted 100 times by D. I. water. In case of α–Fe_2O_3 NPs, the sample preparation was similar to above discussed process except 3 mL conc. HNO_3 was added instead of 3 mL aqua regia.

Table S2

Samples	Fe (Fe_2O_3) wt. %	Cu (CuO) wt. %	Al (Al_2O_3) wt. %	Cr (CrO_2) wt. %	Ni (NiO) wt. %	Total Metal wt. %
Precursor (Rust Scratched from rusted wires)	90.99 (63.27)	0.058 (0.72)	0.3961 (0.7471)	0.023 (0.48)	0.0225 (0.028)	91.4896
Interconnected α–Fe_2O_3 NPs	98.35 (68.764)	0.004 (0.005)	0.0132 (0.0249)	0.0034 (0.007)	0.0130 (0.0162)	98.3836

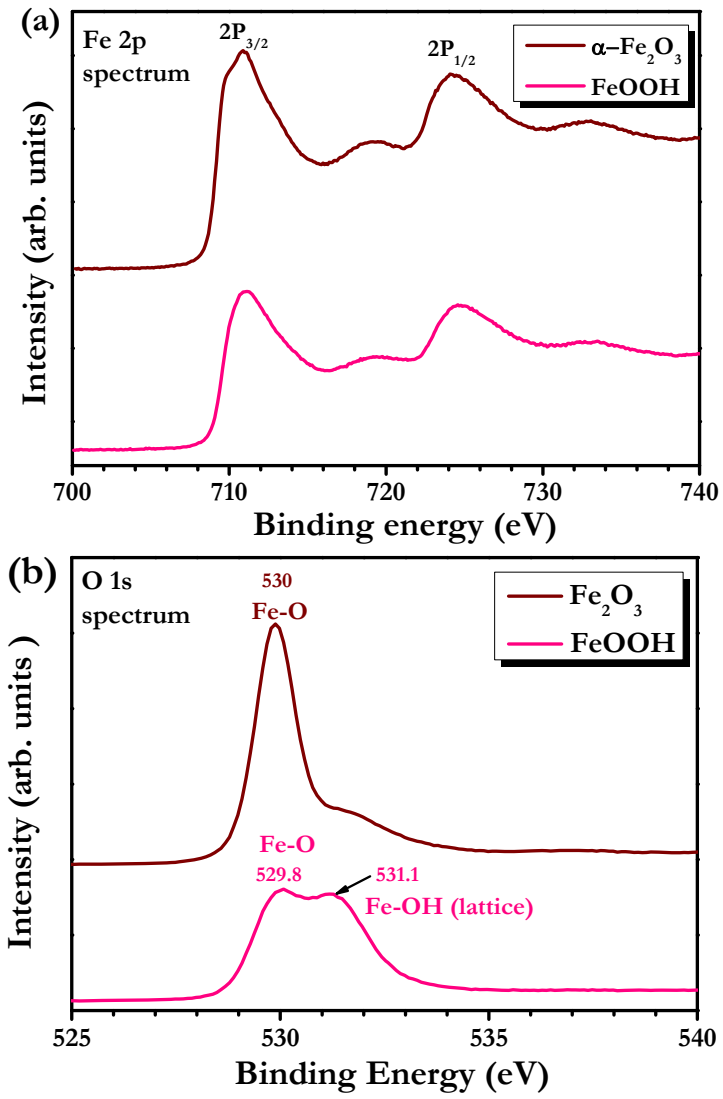

Figure S3: (a) Fe2p XPS plots for α–Fe_2O_3 and FeOOH and b) O1s XPS plots for α–Fe_2O_3 and FeOOH.

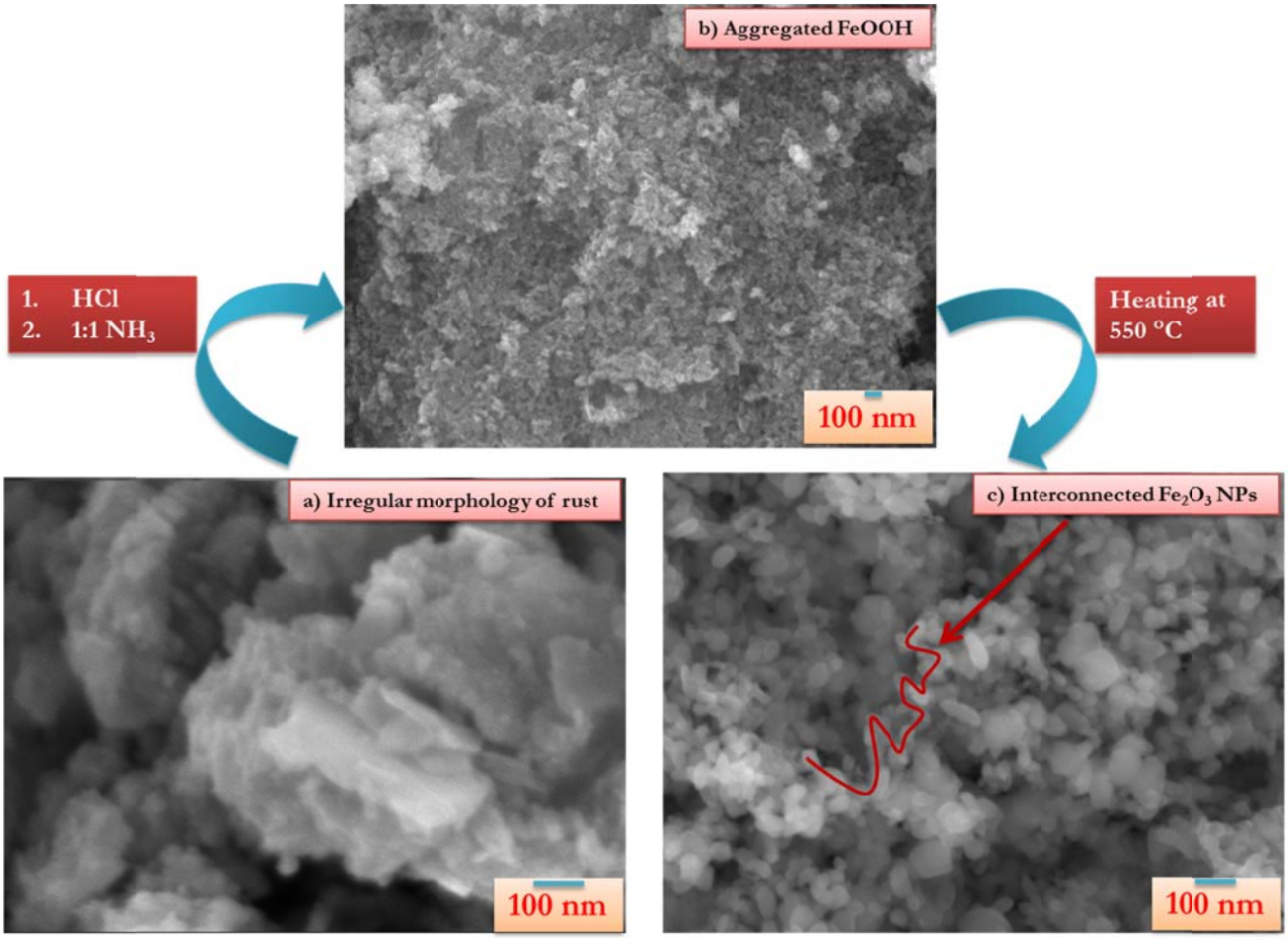

Figure S4: (a) FESEM images for a) Rust (scratched from rusted wire) b) Intermediate (FeOOH) and c) Interconnected α–Fe_2O_3 NPs.

EDAX analysis for α–Fe_2O_3 NPs.

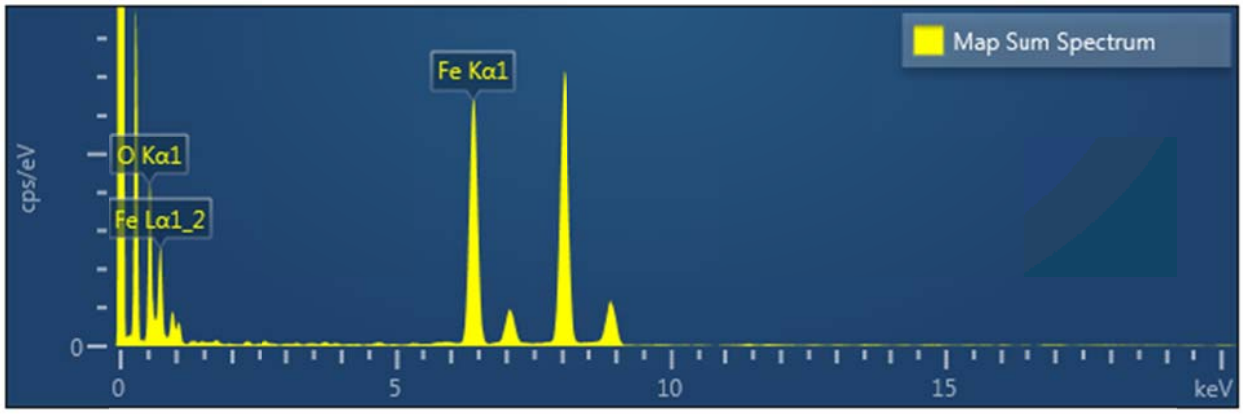

Figure S5 EDAX plot for α–Fe_2O_3 NPs

Table S3: EDAX analysis summary

Element	Line Type	k factor	Absorption Correction	Wt.%	Wt.% Sigma	Atomic %
O	K series	2.13875	1.00	32.15	1.66	62.32
Fe	K series	1.04302	1.00	67.85	1.66	37.68
Total:				100.00		100.00

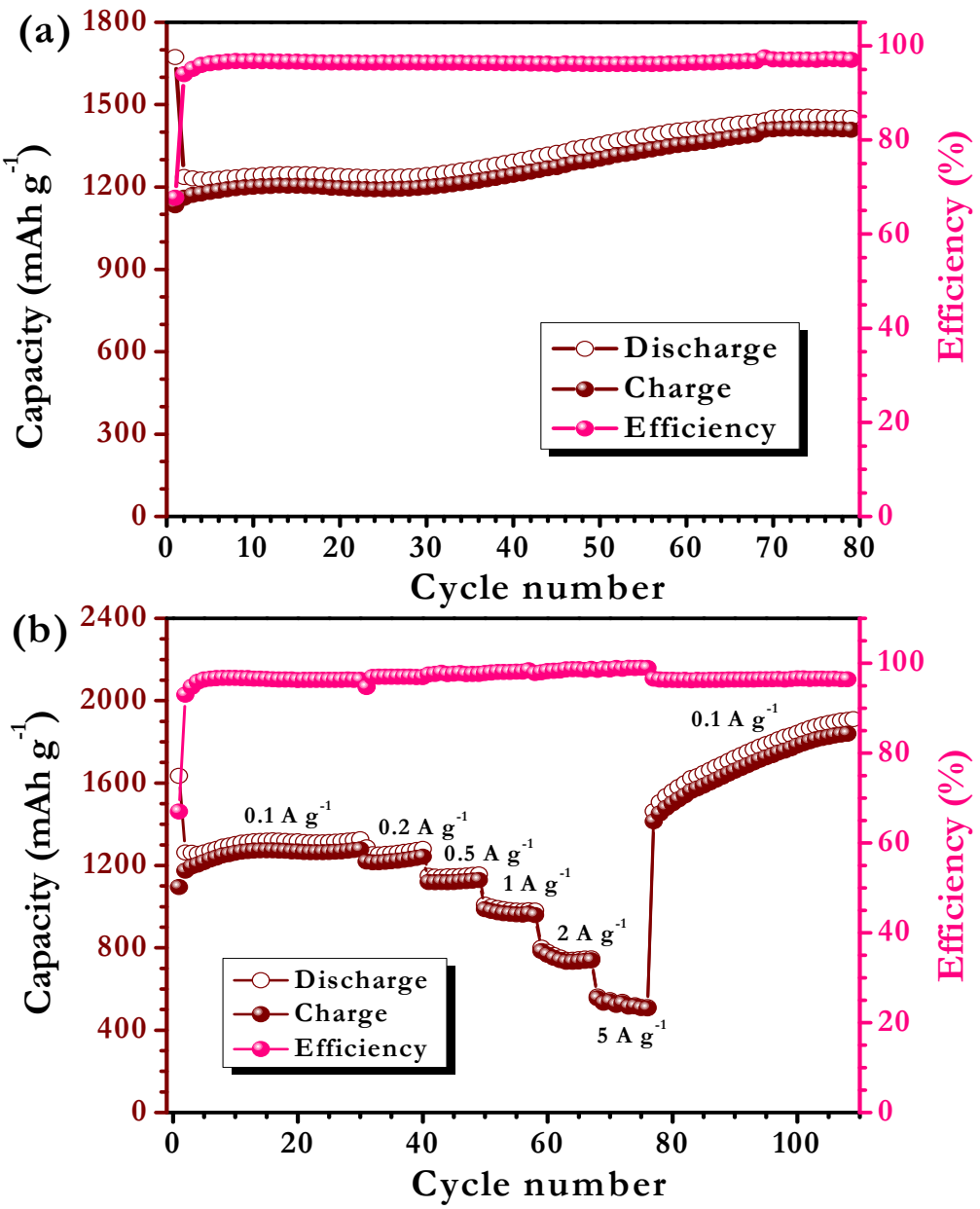

Figure S6: (a) Capacity *vs.* cycle number plot for Li/α–Fe_2O_3 half-cell (Electrode composition: 40:50:10) at current density of 0.1 A g^{-1}, b) Rate capability plot for Li/α–Fe_2O_3 half-cell at various current densities.

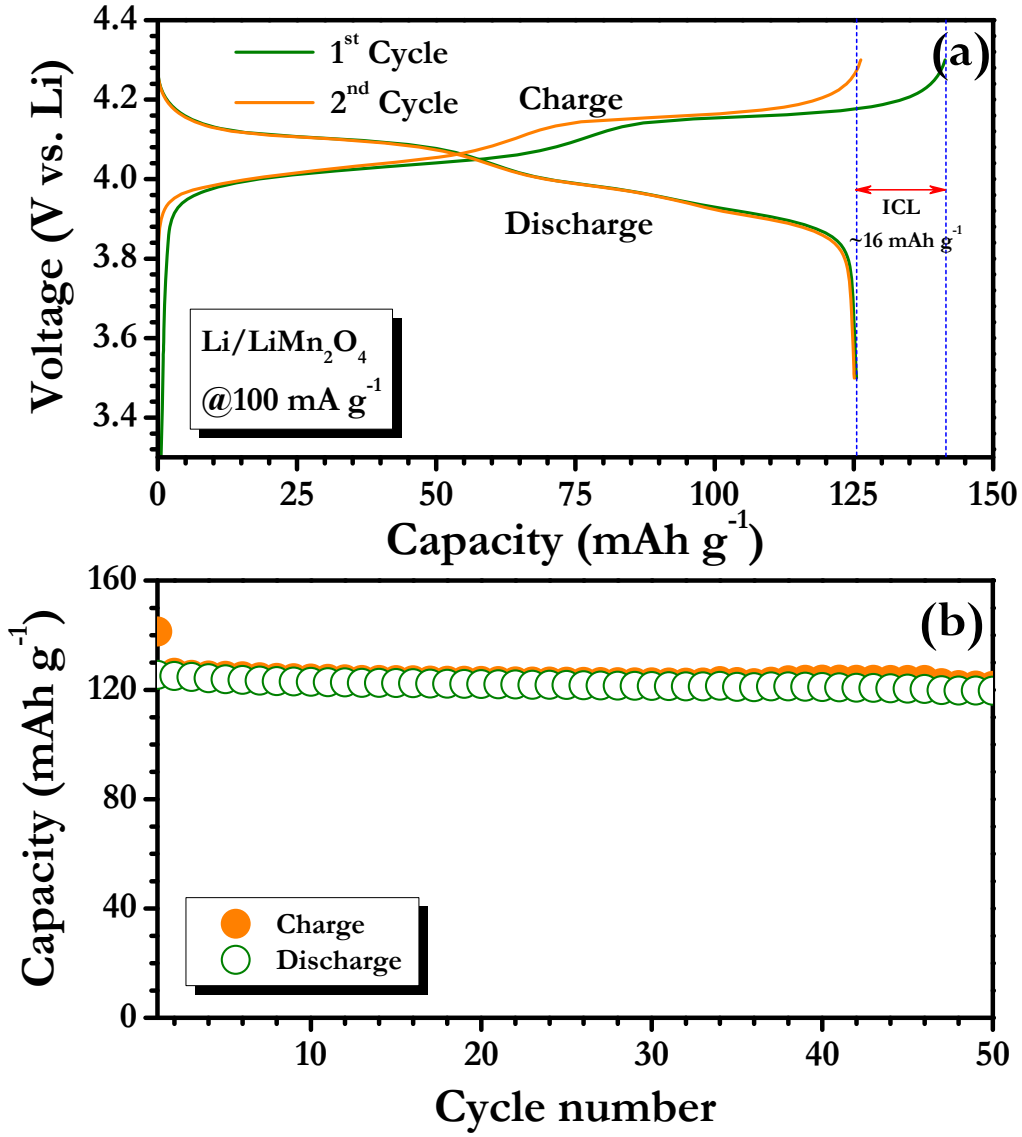

Figure S7. (a) Typical galvanostatic charge-discharge curves of $Li/LiMn_2O_4$ (Merck KGaA, Germany) at current density of 0.1 A g^{-1} between 3.5-4.3 V *vs.* Li in ambient temperature conditions, and (b) Plot of capacity *vs.* cycle number

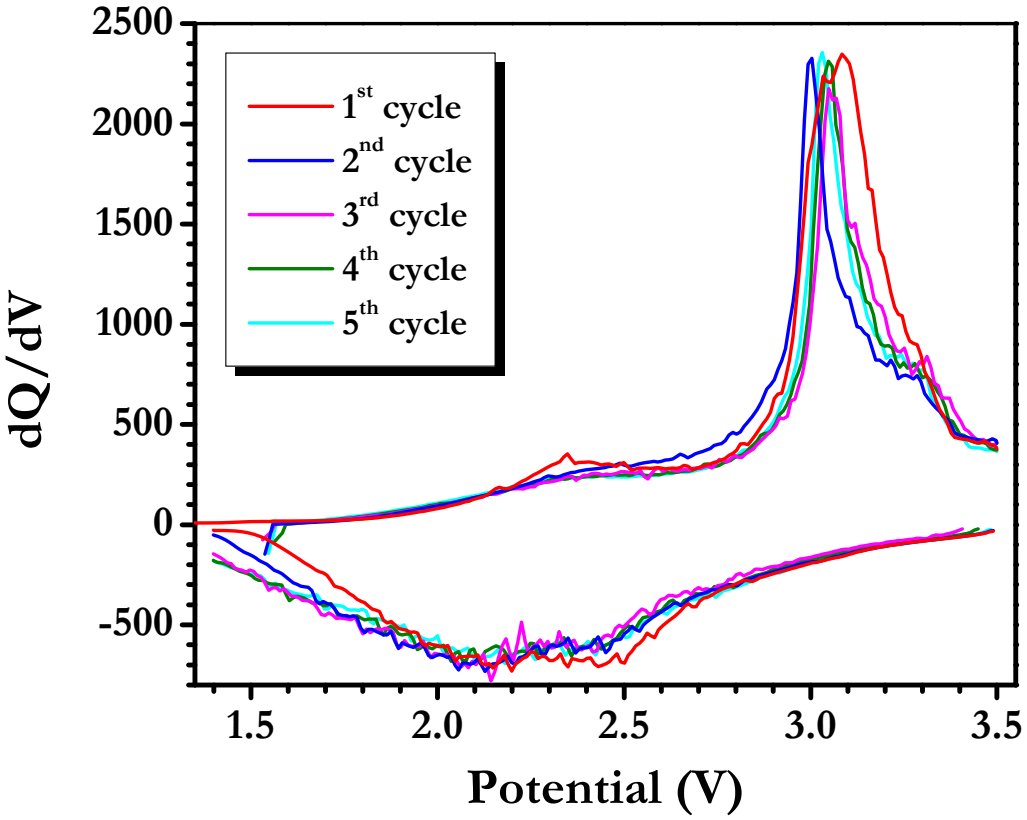

Figure S8. Differential capacity profile of $LiMn_2O_4/\alpha$-Fe_2O_3 NPs cells cycled at current density of 0.1 A g^{-1}.

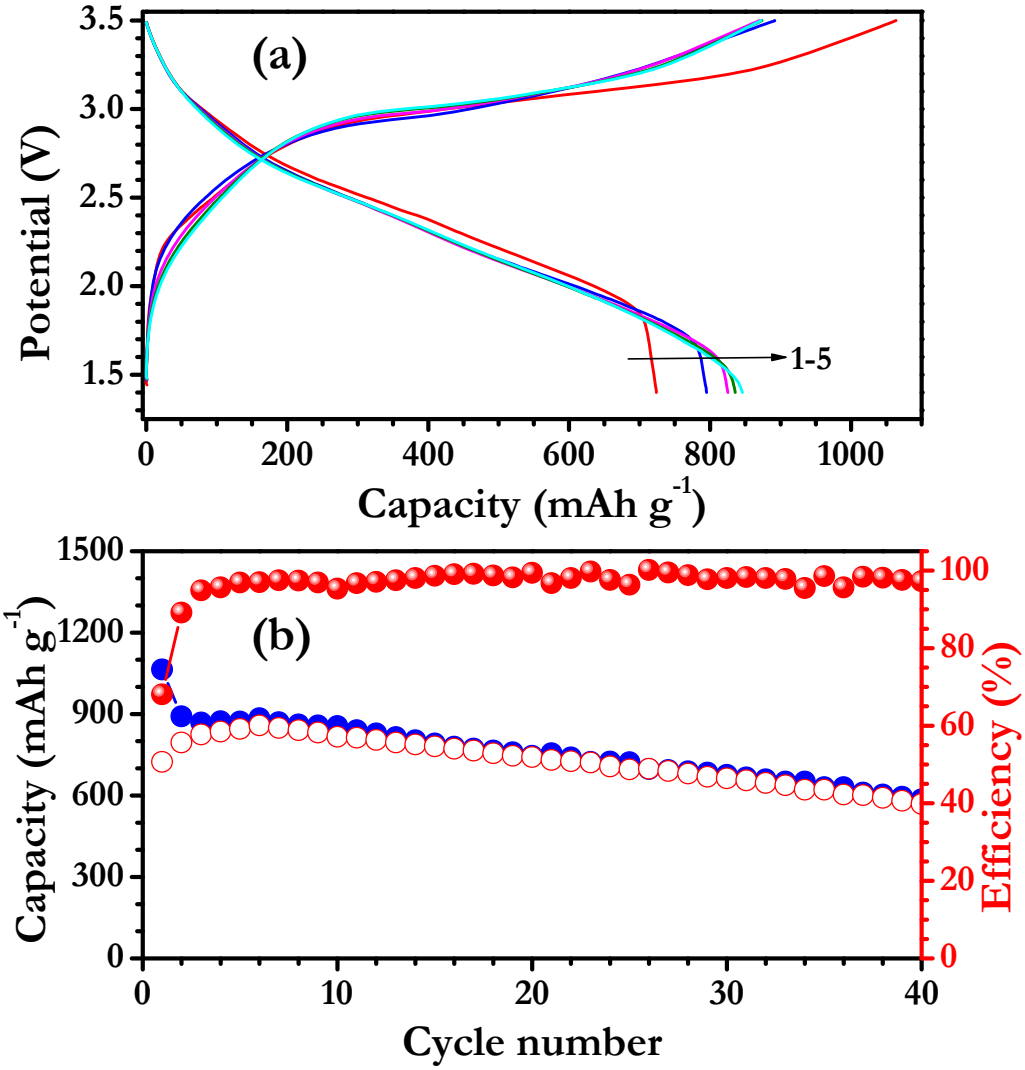

Figure S9. Galvanostatic charge–discharge curves for $LiMn_2O_4$/α-Fe_2O_3 NPs (pre-treated) (Electrode composition: 40:50:10) full cell at a current density of 0.1 A g^{-1}, (b) Plot of specific capacity *vs.* cycle number plot for $LiMn_2O_4$/α-Fe_2O_3 NPs (pre-treated) full cell at 0.1 A g^{-1}.