Investigation of Metal Oxide/Carbon Nano M erial as Anode for High Capacity Lithium-Ion lls

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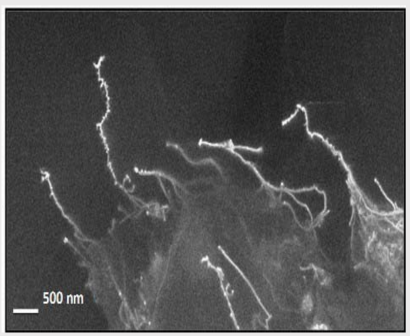
NASA is developing high specific energy and high specific capacity lithium-ion battery (LIB) technology for future NASA missions. Current state-of-art LIBs have issues in terms of safety and thermal stability, and are reaching limits in specific energy capability based on the electrochemical materials selected. For example, the graphite anode has a limited capability to store Li since the theoretical capacity of graphite is 372 mAh/g. To achieve higher specific capacity and energy density, and to improve safety for current LIBs, alternative advanced anode, cathode, and electrolyte materials are pursued under the NASA Advanced Space Power System Project. In this study, the nanostructed metal oxide, such as Fe_2O_3 on carbon nanotubes (CNT) composite as an LIB anode has been investigated.

Nanostructuted Fe_2O_3/CNT

Fe_2O_3: high theoretical capacity (1007 mAh/g), safe, cost-effective, and environmentally friendly, which are considered a promising anode material.

CNT: backbone/host matrix, not only provides excellent electronic conductivity but also as a effective buffering from the volume changes.

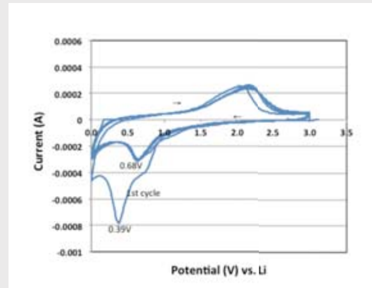


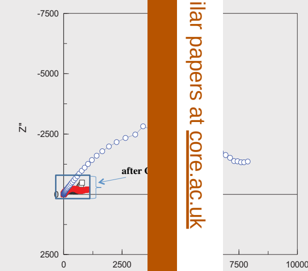
Creating nanomaterial with unique structure could effectively improve the lithium storage properties of the metal oxide. The SEM shows that a unique approach is developed to attach Fe_2O_3 uniformly on CNTs.

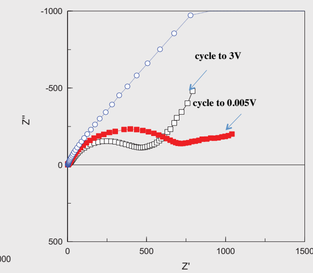
Summary:

- A unique approach for attaching metal oxide uniformly on CNT has been developed
- Fe_2O_3/CNT has demonstrated > 800 mAh/g specific capacity with ~ 98% coulombic efficiency, with excellent rate capability cycling
- Preliminary results show that Fe_2O_3/CNT is a promising anode material for Li-ion cells

Cyclic Voltammetry (CV) & Electrochemic pedance Spectroscopy(EIS)

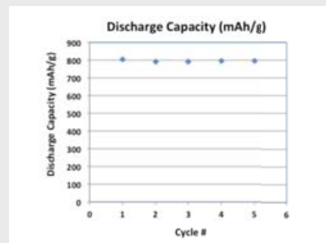


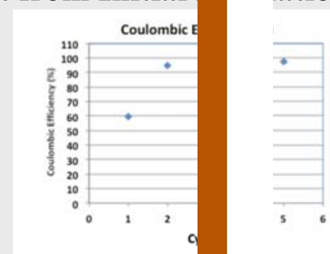




During 1st cycle CV, Fe_2O_3 reacts with Li^+ via con reaction to form Fe^0 and Li_2O, causing irreversible capacity loss, but shows good ibility starting from 2nd cycle.

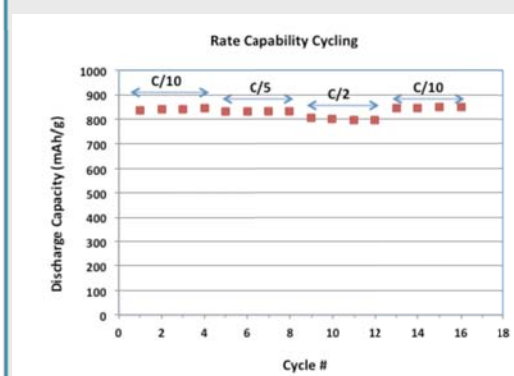
Electrochemical Constant from Initial ation

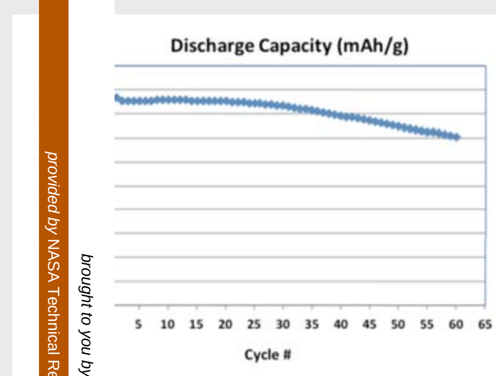




Formation Cycle #	Reversible Discharge Capacity (mAh/g)	Coulombic Efficiency (%)	Irreversible Capacity Loss (%)
1	803	59	68.5
2	790	95	5.4
3	792	96	4.5
4	794	97	3.4
5	795	97	3.0

Cycling Performance





Demonstrated excellent rate capability cycling ar d initial C/10 cycling performance.