Hierarchical SnO_2-Graphene Nanocomposites with Enhanced Performances as Anodes for Lithium Ion Batteries Applied in Electrical Vehicles

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Outline

- Nanomaterials anodes for LIBs
- Sandwiched Graphene/SnO_2 Nanowire/Carbon Nanostructures

  Synthesis, morphologies, performances
- Conclusion and outlook

Why Sn Based Anodes

Equations: $22Li^+ + 22e^- + 5Sn \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}} Li_{22}Sn_5$

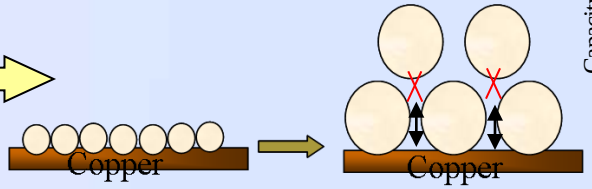
➢ **Advantages: High theoretical capacities**

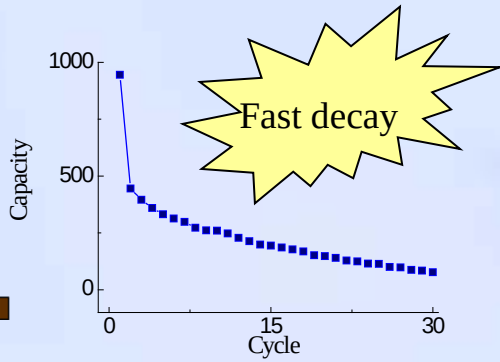
- **Sn: 992 mAh/g SnO: 876 mAh/g SnO_2: 781 mAh/g**
- **Conventional graphite 372 mAh/g LiC_6**

More than twice

➢ **Disadvantages: Poor cycle performance**

- **large specific volume change**
- **rapid pulverization**
- **decrease of electrical conductivity**



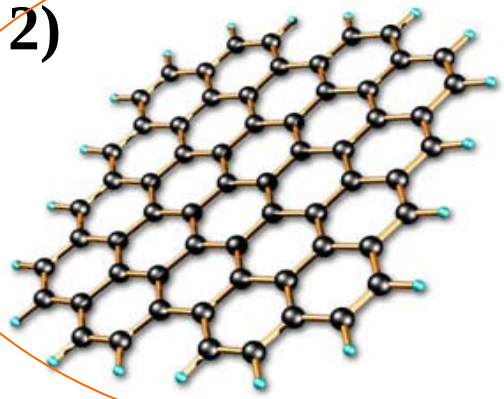


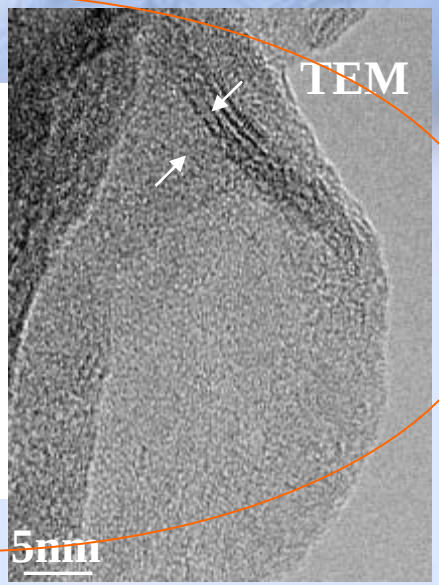
Alloy	Sn	$Li_{7/3}Sn$	$Li_{5/2}Sn$	$Li_{13/5}Sn$	$Li_{7/2}Sn$	$Li_{22/5}Sn$
Volume increase	0	0.53	1.28	1.76	1.99	2.59

Strategies

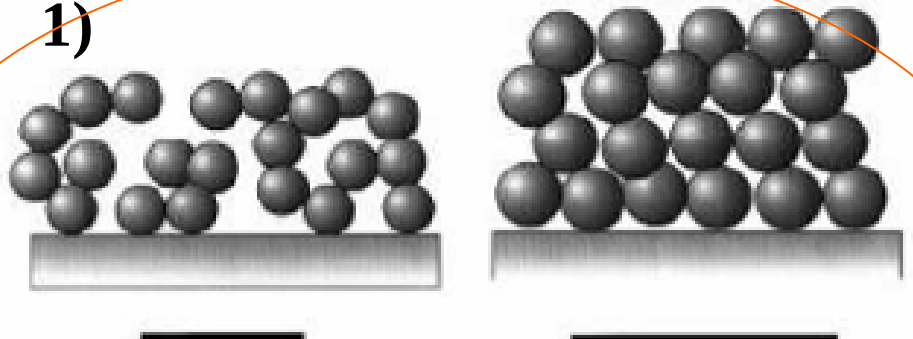
- **Nanostructures;**
- **Carbon hybrids (Graphene);**
- **Metal alloys (Cu, Co, Ni etc.)**

2)





1)



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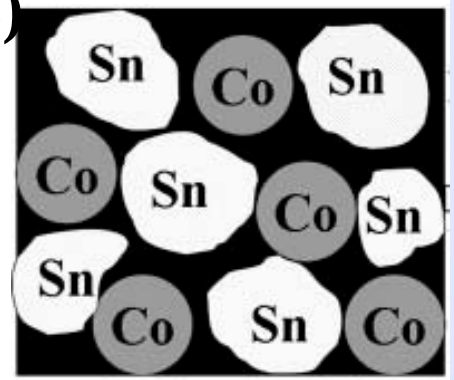


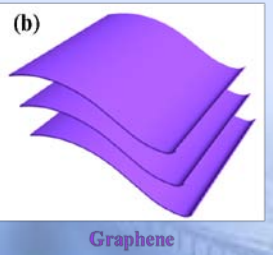
SnO_2/Graphene composites

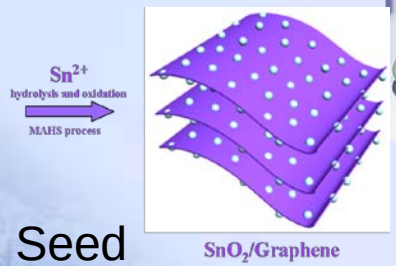
Precursor:
$SnCl_2$ + Graphene
Solvent:
Water

Microwave-assisted hydrothermal system (MAHS)

(a)

1200W
200℃
60min
20bar

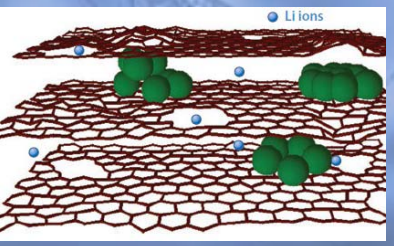


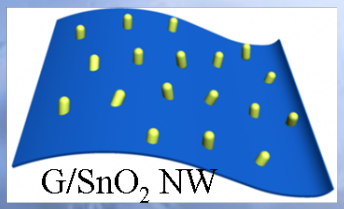


Seed

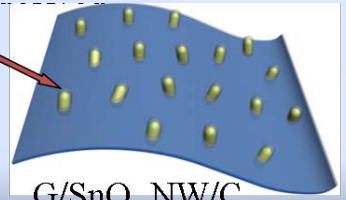
Sandwich

Intact protection

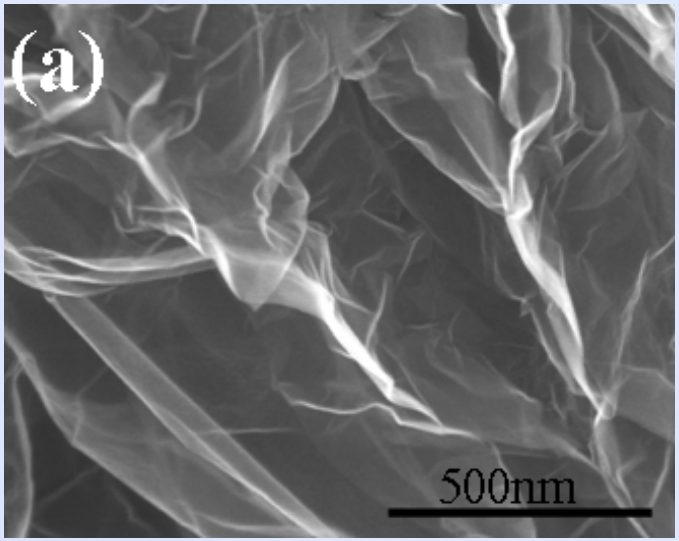




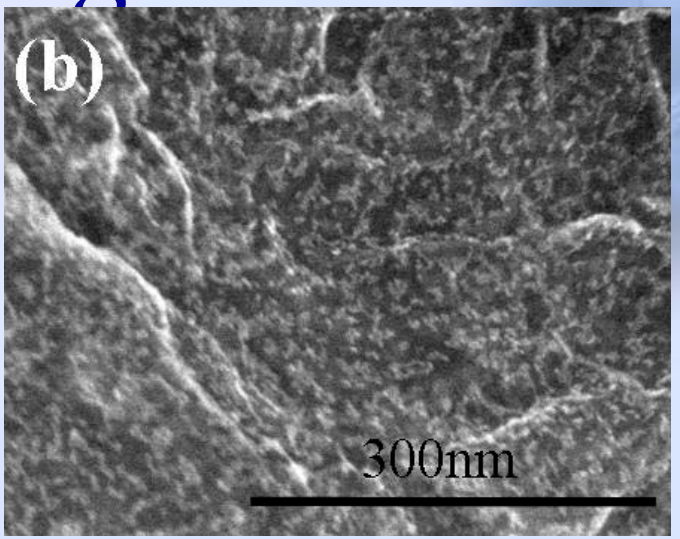
carbon



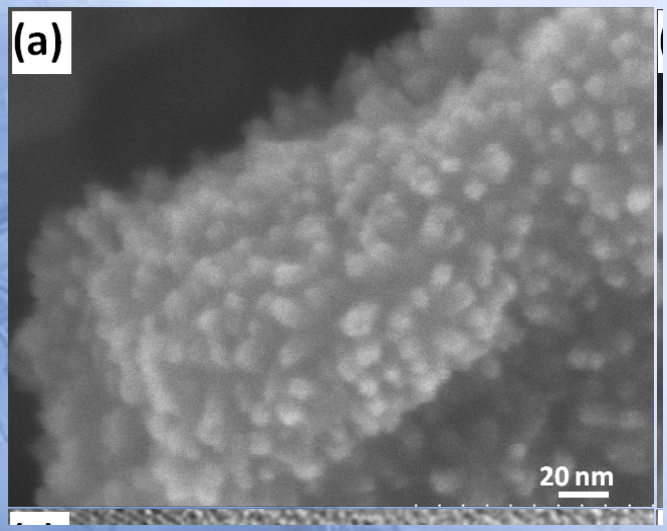
Morphologies



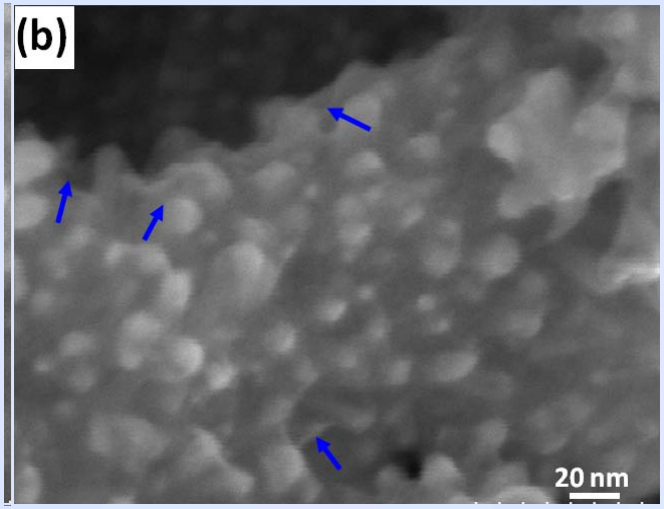
Graphene



Graphene-SnO2 NP

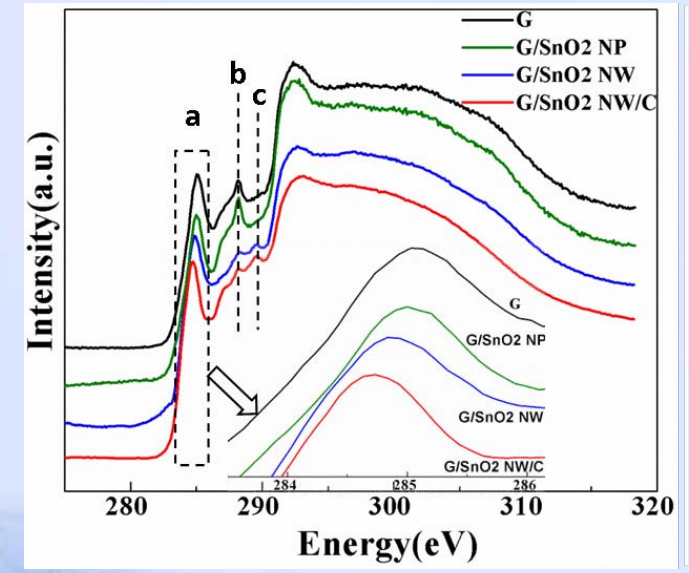


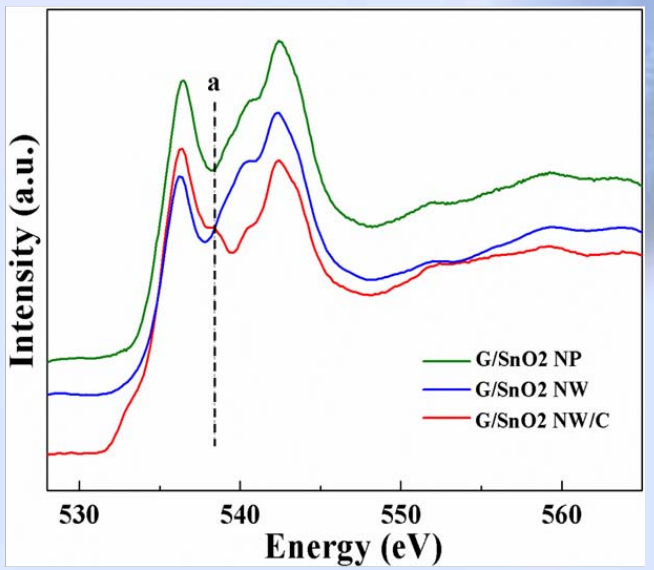
Graphene-SnO2 NW



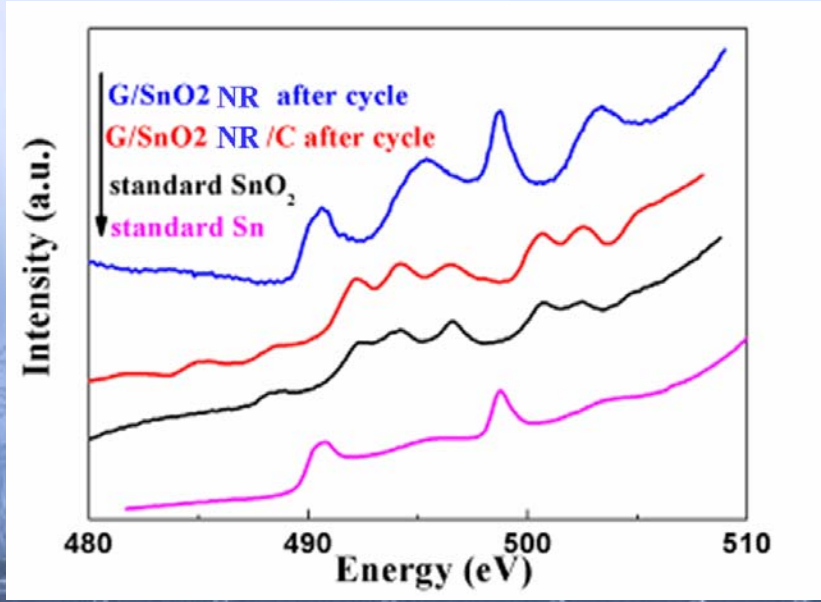
Graphene-SnO2 NW-C

XANES

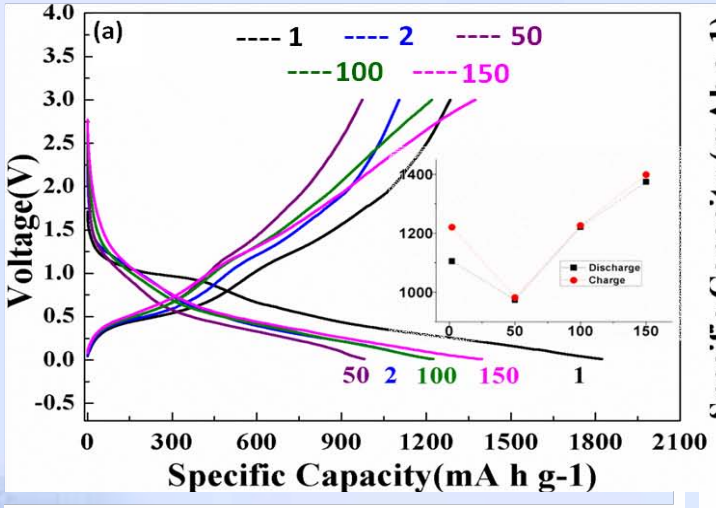


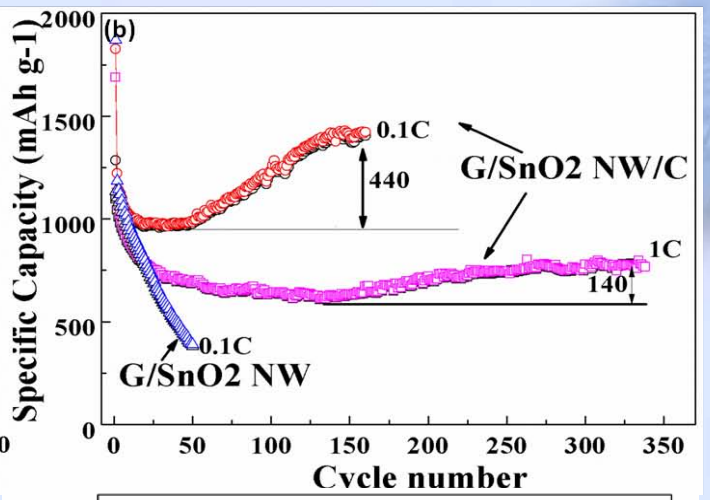


Before Cycling

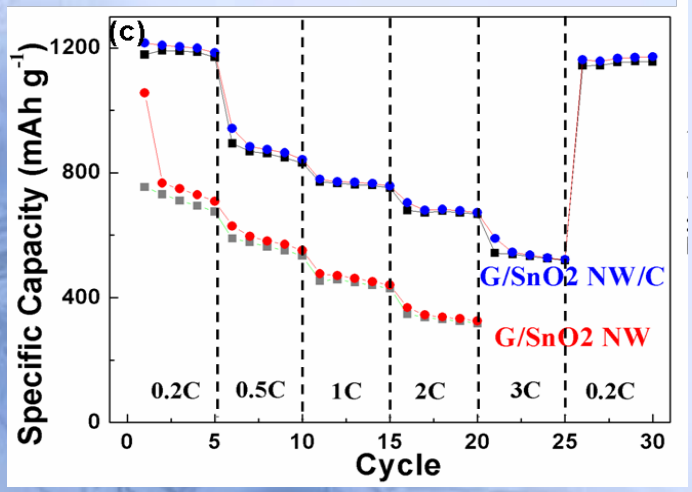


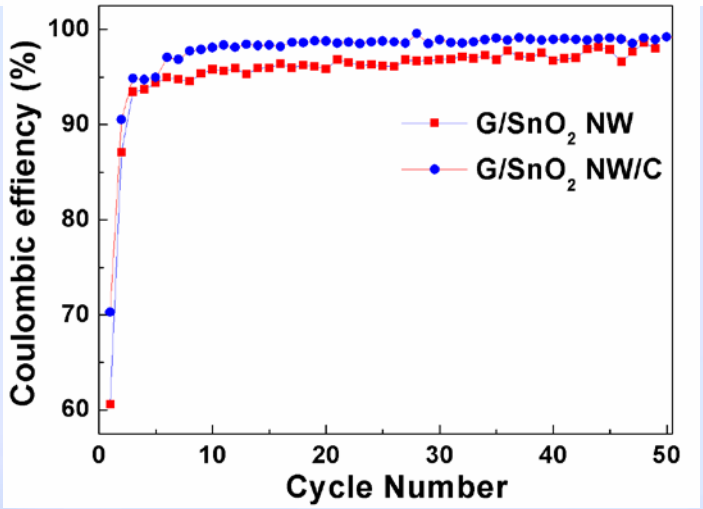
Performances





Capacity upon cycling





$SnO_2 + 4Li^+ + 4e^- \longrightarrow Sn + 2Li_2O$ (1)

Conclusions and Outlook

- A 3D sandwiched carbon coated SnO2 NW grafted on graphene hierarchical structure
- The as-prepared G/SnO2 NW/C nanocomposite exhibits an ultrahigh reversible specific capacity of 1419 mAh g^{-1} in the 150th cycle and high-rate capability at high current densities of 3000 mA g^{-1}.
- Benefiting from the advanced sandwiched hierarchical structure and the intimate chemical bonding between each layers, the nano-hybrids show the enhanced synergistic effect.

Fabrication or design of hierarchical nanocomposites should be direction for high performance electrodes.

Thanks!