Superior shuttling of lithium and sodium ions in manganese-doped titania @ functionalized multiwall carbon nanotubes anode

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Abstract (300 word limit)

In order to improve the electrochemical kinetics of anatase titania (TiO2), Mn-doped TiO_2 incorporated with functionalized multiwall carbon nanotubes (MWCNTs) has been prepared by modified hydrothermal method and tested for both lithium (LIBs) and sodium-ion battery (SIBs) anode. The size of TiO_2 particles is controlled to ~35–40 nm, with almost even distribution on the MWCNTs surface. The nanostructuring and appropriate doping of cost-effective manganese into the TiO2 host improved the electrochemical performance, in terms of high rate capability and specific capacity for both the rechargeable battery systems. For the LIBs, the first cycle charge capacity of 5%Mn-TiO2/MWCNTs anode is 226.3 mAh g^{-1}, and after 80 cycles is retained to 176.4 mAh g^{-1}, as compared to the SIBs, in which the first cycle charge capacity is 152.1 mAh g^{-1}, and after 80 cycles is retained to 121.4 mAh g^{-1}. After testing the electrodes at a high current rate of 20 C, the nanocomposite electrode can still demonstrate charge capacity of 131.2 and 117.2 mAh g^{-1} under 0.1 C rate for LIBs and SIBs, respectively. The incorporation of Mn-ions (2+, 4+) is found to play a crucial role in terms of defects and vacancy creation, increasing conduction band electrons and lattice expansion to facilitate alkali metal ion diffusion for superior electrochemical performance. The combination of heteroatom doping, and use of a highly conductive additive in the form of MWCNTs has resulted in excellent electrode integrity, high ion accessibility, and fast electron transport. The outstanding cycling stability and remarkable rate performance make 5%Mn-TiO_2/MWCNTs a promising anode material for high-performance LIBs and SIBs.

Image

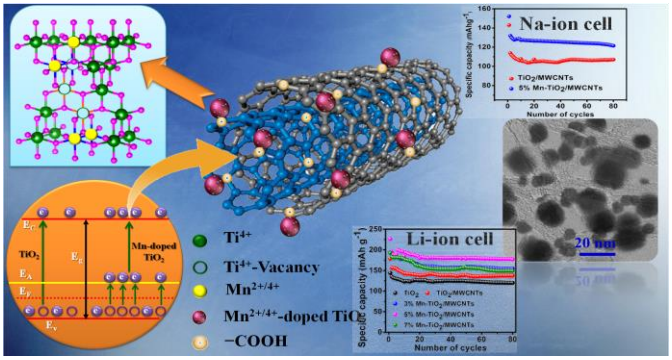


Fig.1 The optimized Mn-doping leads to lowering in the band gap, thus decreasing the electronic resistance, which is beneficial for surface charge transfer processes in multiple cycles

Recent Publications (minimum 5)

1. Ali B, Abbas SM (2018) Interconnected mesoporous Na_2FeSiO_4 nanospheres supported on carbon nanotubes as a highly stable and efficient cathode material for sodium-ion battery. Journal of Power sources 396:467-475.
2. Haris M, Atiq S, Abbas SM, (2018) Acetylene black coated V_2O_5 nanocomposite with stable cyclability for lithium-ion batteries cathode. Journal of Alloys and Compounds 732:518-523.
3. Ata-ur-Rehman, Tirmizi SA, Abbas SM, (2018) Synthesis of highly stable MOF-5@MWCNTs nanocomposite with improved hydrophobic properties, Arabian Journal of Chemistry 11:26-33.
4. Idrees M, Abbas SM, Ata-ur-Rehman (2017) Mechanistic insights into high lithium storage performance of mesoporous chromium nitride anchored on nitrogen-doped carbon nanotube. Chemical engineering Journal 327: 361-370.
5. Bibi M, Abbas SM, Ahmad N (2017) Microwaves absorbing characteristics of metal ferrite/multiwall carbon nanotubes nanocomposites in X-ban. Composite Part B. 114:139-148.



Biography (150 word limit)

Syed Mustansar Abbas completed his doctorate degree from Quaid-i-Azam University, Islamabad, Pakistan and is currently working as a research scientist at National Centre for Physics, Pakistan. He has received Research and Productivity Award (RPA) twice from Pakistan Council of Science and Technology (PCST) and has been among the list of Productive Young Scientist of Pakistan. His area of research lies in the field of synthesis of various nanostructures, nanocomposites and their applications for energy storage and catalysis.

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Notes/Comments: