Proceedings of the 5th International Conference on Nanotechnology: Fundamentals and Applications
Prague, Czech Republic, August 11-13, 2014
Paper No. 231

Accurate Synthesis of Multi-shelled Metal Oxides Hollow Microspheres as Anode Materials for Lithium-Ion Batteries with Excellent Performance

Jiangyan Wang, Quan Jin, Mei Yang, Dan Wang*
State Key Laboratory of Multiphase Complex Systems, Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, P. R. China
jywang@ipe.ac.cn; qjin@ipe.ac.cn; myang@ipe.ac.cn; danwang@ipe.ac.cn

Extended Abstract

Hollow micro-/nano-structured metal oxides are of great interest because their unique structures enable properties that make them attractive materials for applications such as photonic devices, catalysis, chemical sensors, and energy conversion and storage systems, as shown by Dong et al. (2012) and Lai et al. (2011). Among these applications, multi-shelled metal oxides hollow microspheres as electrode materials for lithium-ion batteries (LIBs) are particularly attractive due to the following reasons: 1) The larger surface area enables more access for Li ions, resulting in higher specific capacity. 2) The shorter diffusion paths for both Li ions and electrons, lead to better rate capability. 3) The hollow interior provides free volume for alleviating the structural strain, giving rise to improved cycling stability, as shown by Wang et al. (2013).

Given the above considerations, multi-shelled NiO hollow microspheres are prepared and tested as anode materials for LIBs. The result turns out that quadruple-shelled NiO hollow spheres show the best performance, with a reversible capacity being 1038 mAh g^{-1} for the 50^{th} cycle. Compared to NiO, the theoretical capacity of Co_3O_4 is higher. As a result, multi-shelled Co_3O_4 hollow microspheres are prepared with a high yield and purity. When tested as the anode materials for LIBs, these multi-shelled Co_3O_4 hollow microspheres exhibit excellent rate capacity, good cycling performance and ultrahigh specific capacity (1615.8 mAh g^{-1} at the thirtieth cycle for triple-shelled Co_3O_4). Compared to Co_3O_4, Mn_2O_3 is lower-toxic and cheaper. Considering that, multi-shelled Mn_2O_3 hollow microspheres are prepared with much thinner and corrugated shells. When tested as the anode materials for LIBs, quadruple-shelled Mn_2O_3 hollow microspheres showed an impressive reversible capacity up to 1399.97 mAh g^{-1} for the 50^{th} cycle.

Considering their facile synthesis and the improved performance, it can be expected that these multi-shelled metal oxides hollow microspheres will open a new avenue for the development of the next generation of LIBs with higher specific capacity, better cycling performance and higher rate capacity.

References

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