TUNING THE MICROSTRUCTURE OF HYDROGENATED TIO2 FOR ENERGY STORAGE AND CONVERSION

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Abstract

Hydrogenated TiO2 (H-TiO2) with distinct physical and chemical properties are controlledly synthesized through a hydrogen (H2) plasma treatment, which exhibit excellent performance in application for lithium ion batteries, photocatalysis, and photothermal conversion. Moreover, the microstructure of H-TiO2, and their effect on the application performance of H-TiO2 are comprehensively investigated.

Firstly, hydrogenated anatase TiO2 nanoparticles with significantly improved fast lithlium storage performance are synthesized through a high-temperature H2 plasma treatment. Systematic electrochemical analysis revealed that the improved rate capability of H-TiO2 results from the enhanced contribution of pseudocapacitive lithium storage on the particle surface.

Secondly, H-TiO2 with different hydrogenation degrees are rapidly synthesized through high-power H2 plasma treatment. The slightly hydrogenated TiO2 (s-H-TiO2) with the original white color exhibit enhanced photoactivity compared with the pristine TiO2; while the grey or black H-TiO2 with higher hydrogenation degrees (h-H-TiO2) display much worse catalytic performances. Further investigations reveal that the higher ratio of trapped holes (O- centers) and lower recombination rates induced by the increasing of surface defects might be the critical factors for the high activity of s-H-TiO2; on the contrary, h-H-TiO2 possess high concentrations of bulk defects, leading to the significantly decreased amount of O- centers and enhanced non-radiative recombination, which strongly inhibit their photoactivity.

Thirdly, hydrogenated black TiO2 with large infrared absorption and dramatically enhanced non-radiative recombination, is explored as photothermal agent for cancer photothermal therapy. The results demonstrated H-TiO2 is of low toxicity, and exhibite high photothermal conversion efficiency of 40.8%, which can effectively kill cancer cellls under infrared irradiatation.

Keywords: Hydrogenated TiO2, Li ion batteries, photocatalysis, photothermal effect, photothermal cancer therapy

Author did not supply full text of the paper.