A facile synthesis of TiO₂ nanosphere without any acid treatment

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Titanium dioxide (TiO₂) as a very weighty oxide semiconductor has been extensively accepted for wide areas of applications such as air and water purification, antimicrobial activity, self-cleaning, supercapacitor, lithium ion batteries, hydrogen storage, solar cells, fuel cells, sensors, and more, due to its exceptional sterilizing, photo catalytic, physical and chemical properties. It has been revealed that properties and performance of nanomaterials greatly pretentious to their morphological structures [1].

Figure 1: (a), (b) and (c) FESEM of images of TNS at different magnification (d) EDAX spectrum of synthesized TNS

Anatase TiO₂ hierarchical nanostructures with high surface area are of special importance in various applications. We have reported synthesis of TiO₂ nanosphere (TNS) via facile hydrothermal method, by using Titanium tetraisopropoxide (TTIP) as precursor solution. It is found that TiO₂ nanoparticles work as seed and completely converted into nanosphere like structure or morphology, which are serene of many crystallized anatase nanocrystals. X-ray diffraction spectra confirmed the presence of anatase phase of crystallized TiO₂ nanosphere. Field emission scanning electron microscope has confirmed the nanosphere morphology of TiO₂. With unique features such as low density, high surface to volume ratio and effect of void space in this morphology facilitate light scattering, TNS may have a vast potential applications in the field such as solar cell, photocatalysis, supercapacitor, lithium ion batteries and some related fields.

In the synthesis process, 2 ml of TTIP solution was gradually added during vigorous magnetic stirring in 40 ml ethanol at room temperature. The prepared solution was transferred in to stainless steel autoclave at 120 °C for one hours, then slowly cooled at ambient temperature. After hydrothermal reaction, resulting mixture was collected. The obtained precipitate was washed with deionized water three times and kept at 60 °C oven for dry in an air atmosphere. The product was calcined at 450 °C for 4 hours. Mainly, synthesis of hierarchical nanostructures of nanomaterials highly depend on three steps: first nucleation of seeds, growth of particular structures and assembly of them in certain manners with aid of sundry interactions. The FESEM image of successfully synthesized TNS is shown in Figure 1. From these images, the size of nanosphere was found in the range of 50 nm to 300 nm.

Figure 2: XRD pattern of prepared TNS

The phase composition of TiO₂ hierarchical nanostructures was examined through XRD pattern and is shown in Figure 2. All intense peaks in this pattern correlate with Anatase TiO₂ (JCPDS 21-1272) [2]. The diffraction peaks at the two theta values of 25.2, 37.1, 48, 53.9, 55, 62.7, 68.8, 70.2, 74.9, which corresponds to (101), (004), (200), (105), (211), (204), (116), (220) and (215), crystals planes of anatase phase TiO₂, respectively.

References

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2. X. Tao, P. Ruan, X. Zhang, H. Sun, X. Zhou, Nanoscale 7(2015) 3539.