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Advanced Nanostructured Materials and Their Application for Solar Fuel

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Abstract : Highly crystalline, TiO_2 pristine sub-10 nm anatase nanocrystals were fabricated at low temperatures by post hydrothermal treatment of the as-prepared TiO_2 nanoparticles. This treatment resulted in bandgap narrowing and increased photocurrent density value (3.8 mA/cm^2) when this material was employed in water splitting systems. The achieved photocurrent values are among the highest reported ones so far for the fabricated nanoparticles at this low temperature. This might be explained by the increased surface defects of the prepared nanoparticles. It resulted in bandgap narrowing that was further investigated using positron annihilation experiments by measuring positron lifetime and Doppler broadening. Besides, homogeneous spherical TiO_2 nanoparticles were synthesized in large diameter and high surface area and the high percentage of (001) facet by sol-gel method using potassium persulfate ($K_2S_2O_8$) as an oxidizing agent. The fabricated particles exhibited high exposed surface area, high photoactivity and reduced band gap. Enhanced performance for water splitting applications was displayed by formed TiO_2 nanoparticles. Their morphological and structural properties were studied to optimize their synthesis parameters in an attempt to construct more applicable fuel cells in the industry for hydrogen fuel production.

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