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Nanostructured catalysts for water splitting with hydrogen production

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The surface of the Earth's crust receives more than 95% sunlight in the range of visible light (mostly 400-600 nm) and for this reason visible light driven photocatalysts have been heralded as a crucial breakthrough in photocatalytic processes for water splitting. In fact, from a practical point of view, the most important factor for applying the sunlight absorption to water splitting for hydrogen production is the discovery of efficient and stable photocatalysts. These photocatalysts are semiconductor materials consisting of essentially an electron occupied valence band and an unoccupied conduction band. This process has been regarded as a promising solution to resolve the global energy and environmental problems. In this research, photocatalysts based on Au@TiO₂ nanowires have been synthesized by hydrothermal approach. These catalysts were obtained as layers of ca. 100 μm-thick, that were grown on the surface of monocrystalline Si (100) wafers. The catalytic activity was measured by putting water (with Na₂S and Na₂SO₃ as sacrificial reagents) into contact with the Au@TiO₂NWs catalyst supported on Si wafers, at room temperature and atmospheric pressure. The water splitting reaction was conducted in a quartz reactor equipped with a water-cooling jacket. The reaction mixtures were irradiated at different light wavelengths (from 220 to 700 nm) using a solar simulator and appropriate cutoff filters in a static air atmosphere. The evolved gases were analyzed by gas chromatography with a thermal conductivity detector using N₂ as carrying gas. The effect of the different synthesis parameters (synthesis temperature, Au-Ti atomic ratio, and calcination temperature) on the photocatalytic production of hydrogen has been studied in order to determine the best experimental conditions. The catalysts have been characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), and BET.

Biography

Francisco Márquez was born in Valencia (Spain) and received his Bachelor and Master's degree in Biochemistry at the Universidad de Valencia in 1988 and 1989, respectively, and his Doctor's degree in Chemistry at the Universidad de Valencia in 1992. He spent 2 years from 1990 as Director of the laboratories of Futura Medical S.A. and 1 year as research associate at the VI Laboratories. From 1994 he worked as a post-doctoral associate at the Universidad Politécnica de Valencia. In 2001, he was an Associate Professor at the Universidad Jaime I and subsequently he moved to the School of Science and Technology at the Turabo University in Puerto Rico, USA. Since 2008 he is a Full Professor. He has been Visiting Professor in several universities, most recently at the Universidad Autónoma de Madrid. His research interests are mainly directed toward photophysics of organic compounds in confined spaces, hydrogen technology and most recently the synthesis and applications of nanotubes and nanowires. He is a co-author of over 90 scientific publications and 10 patents.

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XPS, photoluminescence and morphology effect of RE³⁺ (RE= Ho, Er) ions in ZnO nanostructures

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This investigation describes the production of ZnO nanostructures containing Ln³⁺ (Ln= Er, Ho) ions by using a conventional sol-gel synthesis method. The quantum dots produced exhibit hexagonal wurtzite structure in both ZnO and ZnO: Ln³⁺ samples. Morphology change was observed with dopant concentration increase, which is seen to be the result of the Ostwald ripening effect occurring during the nanocrystals growth. The photoluminescence properties of the samples have also been studied under room temperature conditions. The Ln³⁺ ions luminescence lines 4f-4f electronic transition was detected in ZnO: Ln³⁺ samples. Finally, defect state in the samples was analyzed using X-ray Photoelectron Spectroscopy (XPS) technique.

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