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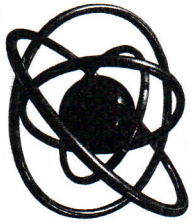
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Abstract:

A state-of-the-art of the photoelectrochemical hydrogen production using TiO₂ is presented. Some authors report [1] show that TiO₂ incorporated in a zeolite-based material with heteropolyacid (HPA) and cobalt has an high efficiency for water splitting under visible light irradiation. Hydrogen generation to the tune of 2171 $\mu\text{mol/h/g}$ of TiO₂ has been achieved for this composite material, compared with an H₂ evolution rate of 131.6 $\mu\text{mol/h/g}$ for Degussa P25. The synthesis of TiO₂ and N-doped TiO₂ thin films using a pulsed direct current plasma assisted chemical vapour deposition (PACVD) technique has been proposed[2]. This type of deposition has advantages over the conventional radio frequency methods in that the cost of power generator is lower and the potential for scaling up for industrial applications is higher. The incident photon conversion efficiency (IPCE) for splitting water is about 80% in UV region. Literature data [3] report the preparation of vertically grown carbon-doped TiO₂ (TiO₂-xCx) nanotube arrays that show much higher photocurrent densities and more efficient water splitting under visible-light illumination (> 420nm) than pure TiO₂ nanotube arrays. The total photocurrent was more than 20 time higher than that with a P-25 nanoparticulate film under white-light illumination. Another field of interest regards the so-called "Gratzel Cells"[4], dye-sensitized solar cells (DSSC), which are complex solid/liquid system. It is composed of nano-porous wide band gap oxide layer, covered with a sensitizing dye layer and an electrolytic solution permeating its entire thickness. The nanoparticulate oxide layer is generally TiO₂ covered with a monolayer of charge transfer dye, the ruthenium based "N3" dye [Ru(4,4' - dicarboxy - 2,2' - bipyridine)₂(NCS)₂] being one of the most effective [5]. On absorption of photons, the dye injects electrons into the conduction band of TiO₂. This process is extremely rapid, sub-picosecond regime, and almost 100% efficient. The electron collecting layer in a DSSC is typically a 10 μm thick nanoparticulate film, with a three dimensional network of interconnected 15-20 nm sized nanoparticles [6]. In this system, the arrangement of highly ordered titania nanotube array perpendicular to the surface permits facile charge transfer along the length of the nanotube from the solution to the conductive substrate, thereby reducing the losses incurred by the charge-hopping across the nanoparticle grain boundaries.[7]

Following this path, highly order TiO₂ nanotube arrays up to 220 μm has been obtained using a 0.3% NH₄F and ethylene glycol solution (2% water) at anodization potential of 60V for 17h. The same authors also prepare 30 μm nanotube arrays, which give a remarkable photoconversion efficiency of 16.25% under UV and a light to electricity photoconversion efficiency of 6.95%.

Biosketch

April 2006: Degree in chemistry taken in Rome, at La Sapienza university, with a thesis about polymeric membranes for PEFC. The thesis was made at the ENEA Casaccia labs with the collaboration of dr. Alfonso Pozio.

Nov 2007: The author started his PhD at La Sapienza University

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about photoelectrolysis of water with M. Pasquali, professor at chemical, material and environment engineering department of La Sapienza, Rome, and with the collaboration of dr. Alfonso Pozio from ENEA Casaccia labs.