UNIONE EUROPEA

REGIONE DEL VENETO

Organizers:

veneto nanotech
small technology big applications

Airi Associazione Italiana per la ricerca industriale
nanotec IT

In collaboration with:

Veneto innovazione
meeting the future

nòva 24

Gold Sponsors:

Eni

VENETO BANCA

nanotec2008.it

Nanotechnology for Industry 2015

Venezia, 10th - 14th March 2008

10th-13th March 2008: Nanotec2008.it - Nanotechnology for Industry 2015
14th March 2008: Nanotechnology for Businesses

- Governing Nanotechnology
- Sustainable Mobility
- Life Sciences
- Cultural Heritage
- Energy Efficiency
- Made in Italy

Conference Abstracts

www.nanotec2008.it

Supporters:

CAMERA COMMERCIO INDUSTRIA ARTIGIANATO AGRICOLTURA PADOVA

CAMERA DI COMMERCIO INDUSTRIA ARTIGIANATO E AGRICOLTURA VENEZIA

CAMERA DI COMMERCIO INDUSTRIA ARTIGIANATO AGRICOLTURA VICENZA

A.P.E. Research

elettra

ENEA

CTG Italcementi Group

Dipartimento Progettazione Molecolare

TETHIS

PIRELLI LABS

SELEX Sistemi Integrati

CRF CENTRO RICERCHE FIAT

hitec

Centro Sviluppo Materiali S.p.A.

ENERGY EFFICIENCY

TIO2-BASED PHOTOELECTROCHEMICAL HYDROGEN PRODUCTION: A STATE-OF-ART.

F. Mura*, M. Pasquali* and A. Pozio**

* *Department of chemical, material and environment engineering, La Sapienza, Rome, Italy*

** *ENEA Casaccia Research Center, Hydrogen and Fuel Cells Project, S.M. di Galeria - Rome, Italy*

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 heteropoliacid (HPA) and cobalt has an high efficiency for water splitting under visible light irradiation. Hydrogen generation to the tune of 2171 µmol/h/g of TiO2 has been achieved for this composite material, compared with an H2 evolution rate of 131.6 µmol/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' – dicarbozy – 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 tipically a 10µm 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 30µm nanotube arrays, which give a remarkable photoconversion efficency of 16.25% under UV and a light to electricity photoconversion efficiency of 6.95%.

[1] N. Dubey, N.K. Labhsetwar, S. Devotta, S.S. Rayalu, Catal Today 129 (2007) 428-434

[2] L.K. Randeniya, A. Bendavid, P.J. Martin and E.W. Preston, J. Phys. Chem. C 111 (2007) 18334 – 18340

[3] J.H. Park, S. Kim and A.J. Bard, Nano Letters 6 (2006) 24-28

[4] B. O'Regan and M. Grätzel, Nature 353 (1991) 737-740

[5] S. Gledhill, B. Scott and B.A. Gregg, J. Mater. Res. 20 (2005) 3167-3179

[6] M. Grätzel, J. Photochem. Photobiol. A 164 (2004) 3-14

[7] G.K. Mor, O.K.Varghese, M. Paulose, K. Shankar and C.A. Grimes, Solar Energ. Mat. & Solar Cells 90 (2006) 2011 - 2075

[8] K. Shankar, G.K. Mor, H.E. Prakasam, S. Yoriya, M. Paulose, O.K. Varghese and C.A. Grimes, Nanotech. 18 (2006) 065707

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 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.

Francesco Mura Dip. di Ingegneria Chimica Materiali Ambiente, Via del Castro Laurenziano n°.7 - 00161 Roma
Telephone: +39 06 3048 4004 - Fax: +39 06 3048 6357
e-mail:francescomura1980@googlemail.com