DOPED TiO_2 FOR THE PHOTO-OXIDATION OF WATER BY VISIBLE LIGHT

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The overall objective of the project is to advance the technology for photo-electrochemical conversion of carbon dioxide and water from a state-of-the art overall efficiency of 0.2% under solar irradiation conditions to more than 10%. This overall efficiency is defined as combustion energy of produced fuels divided by incoming solar energy. The novel devices developed within the project will work under solar irradiation, will be cheap in manufacturing, will have a high efficiency, and will operate with a high reliability. At UU the primary aim is to prepare suitable photoanodes to be integrated into a photoelectrochemical cell for the photocatalytic splitting of water and reduction of CO_2. Semiconductors are capable of splitting water into hydrogen and oxygen under UV irradiation. In order to achieve oxidation of water by visible light using semiconductor electrodes, their band gaps must be smaller than 3.0eV or they must have gap states that are sensitive to visible light. Attempts to improve the performance of TiO_2 as a photocatalyst under UV illumination and to extend its light absorption and conversion capacity to the visible region of the solar spectrum have primarily been concentrated on the effect of dopants. The present study investigates TiO_2 photoanodes prepared via a sol-gel method, with and without added transition metal dopants. Both lattice doping and surface doping were investigated. Films were characterised by electrochemical methods in a two compartment cell under three types of illumination UV, solar simulated and under visible light. Under UV illumination doped photocurrent response of TiO_2 electrodes was greater than that of Degussa P25 of similar dimensions. The most photoactive electrode was the undoped TiO_2 electrode. With the doped electrodes the photocurrent response was inversely proportional to dopant concentration. A similar trend was found with UV simulated and solar simulated light. However under illumination with light >400nm, doped films were shown to elicit photoresponses measurable in the μA range with the best samples being doped.

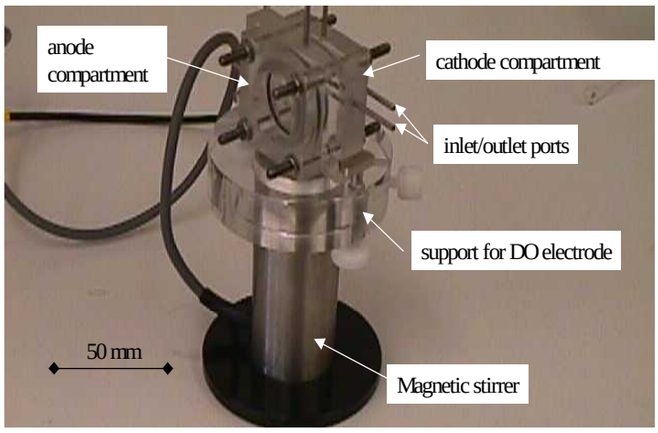

Figure 1: Two compartment photoelectrochemical cell

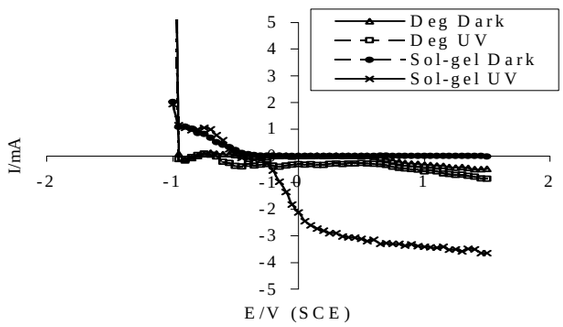

Figure 2:Comparison of Degussa P25 photoanodes and sol-gel photoanodes under UV illumination under O_2 sparged conditions

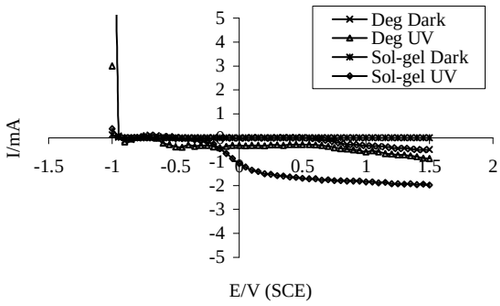

Figure 3: Comparison of Degussa P25 photoanodes and sol-gel photoanodes under UV illumination under N_2sparged conditions