Master Thesis - Abstract

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Investigation on Conduction Processes in Mesoporous Nano-Crystalline Titanium Dioxide Films of Dye Sensitized Solar Cells: Light and External Pressure Effects

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The study of the charge transport processes in "dry" [2] nano-crystalline mesoporous Titanium dioxide thin films used as working electrodes in Dye Sensitized Solar Cells could give a considerable contribution to the performance improvement of this technology. Charge transport without static macroscopic built-in electric field is limited by several factors in DSC. For example recombination processes or trapping processes in intra-gap states induced by high defectiveness of TiO_2 nano-crystals network. [1] The knowledge of these dynamics is fundamental in order to increase the device efficiency. [2]

My work spanned from in-depth morphology characterization (AFM, FE-SEM) of some hand crafted sample and other ready-made available samples, to the their electrical behaviour with respect to illumination and external pressure conditions. Titania electrodes for DSC are generally obtained by sintering of a colloidal TiO_2 nano-crystalline suspension on TCO glass at about 400 C for a few hours. The size of the TiO_2 crystals ranges between 15 and 400 nm, with many possible grain-size distribution (mono or multi-disperse).

Both UV lamp light and He-Ne LASER were used as sources, and two different level of pressure [3] were imposed to the titania films, as is widely reported in literature that Oxygen partial pressure plays a fundamental role in TiO_2 charge conduction. [3]

Performed measurements showed a stretched exponential behaviour in photo-current transients, distinctive mark of a dispersive transport process. It seems to be a consequence of contributions from trap states having very different time constants and density at different energies. A better knowledge of the stretch factor with respect to morphological and energetic factors could lead to a consistent enhancement of DSC technology. I-V characteristics showed that adsorbed oxygen plays a primary role in the semiconductor behaviour of TiO_2 , and a relative high photo-activity of nc-TiO_2 also without adsorbed light sensitizer were noticed in all the performed measurements.

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[2] Without electrolyte filling

[3] $P_{air} = 10^3$ mbar and $P_{vacuum} \leq 10^{-5}$ mbar

References

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