

Microscopy techniques for dye distribution in DSCs nanocrystalline TiO₂ films

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Capture of sunlight has attracted an increasing interest in the scientific community and triggered the development of efficient and cheap photovoltaic devices. Amongst recent generation technologies for solar energy conversion, dye-sensitized solar cells (DSCs) show an optimal trade-off between high-conversion efficiency and low-cost manufacturing.

For the last two decades, significant progress has been made and best energy conversion efficiency of the DSC at the laboratory scale has surpassed 11%. A lot of work has focused on the enlargement of surface areas to enhance the amount of adsorbed dyes by reduction of nanoparticle sizes or utilization of novel structures. Despite this progress, there remain some crucial details of DSC operation for which limited information is available. One area is the study of dye diffusion, adsorption, and surface coverage as well as the question as to whether the dye is homogeneously spread throughout the nc-TiO₂ film.

Microprobe techniques can be powerful tools to evaluate the dye load, the dye distribution and dye depth profile in sensitized films. Electron Probe Microanalysis (EPMA) and Ion beam analytical (IBA) techniques using a micro-ion beam, were used to quantify and to study the distribution of the ruthenium organometallic (N719) dye in TiO₂ films, profiting from the different penetration depth and beam sizes of each technique. Two different types of films were prepared and sensitized, mesoporous nanoparticles and 1D nanostructured TiO₂ films (figure 1).

Despite the low concentration of Ru atoms the high sensitive analytical techniques used provided promising results to assess the Ru surface distribution (figure 2) and depth profile (figure 3). Preliminary data indicate different dye load (Ru/Ti values between 0.4-2 %) depending on the TiO₂ film thickness, being the Ru distribution homogenous during the first nanometers from the surface (figure 2).

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