The Charge Extraction Method as a tool for studying Dye-Sensitized Nanocrystalline Solar Cells

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The charge extraction method is a powerful tool for studying the transport, trapping and back reaction of photogenerated electrons in Dye Sensitised Nanocrystalline (DSNC) solar cells [1]. This technique has been applied to a variety of cells and the results interpreted. In conjunction with the experimental work, a 1D model of charge transport through the DSNC was developed using the finite difference method. The model was used to investigate the effect that trapping/detrapping and electron recombination processes have on the output from a charge extraction experiment.

The sequences of events during a charge extraction experiment are shown in figure 1. The cell is illuminated from the substrate side by an LED. A photostationary state is reached where the rate of injection of electrons equals the rate of back reaction of electrons with the redox mediator in the cell. The LED is then switched off and the decay in the photovoltage is measured for a fixed period of time called the delay time, t. Next the cell is short-circuited and the current is measured. The current output is integrated across a low drift analogue integrator to obtain the extracted charge.

The decay of the electronic charge stored in the TiO_2 and the SnO_2 can be plotted as a function of time. In this way information can be obtained on the kinetics of electron decay due to back reaction with oxidized species at the TiO_2|electrolyte interface and at the SnO_2|elctrolyte interface. A direct link can also be made between the stored charge density and the photovoltage, providing a way of probing the density of states functions for electron traps.

Figure 1. Experimental arrangement for charge extraction experiments

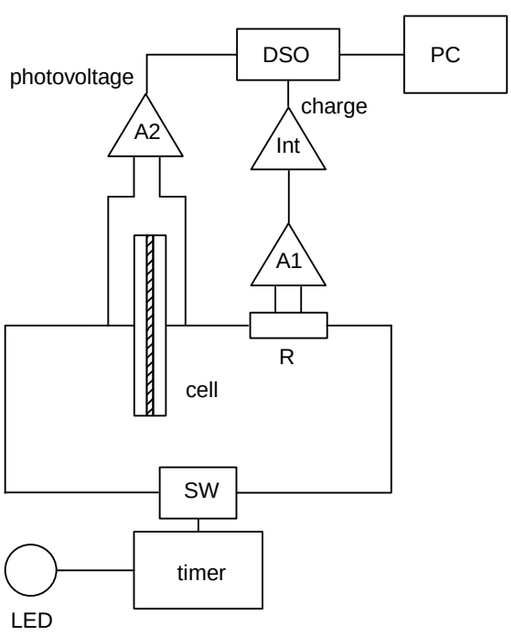


Figure 2. The sequence of events during a charge extraction experiment. SC = short circuit, OC = open circuit.

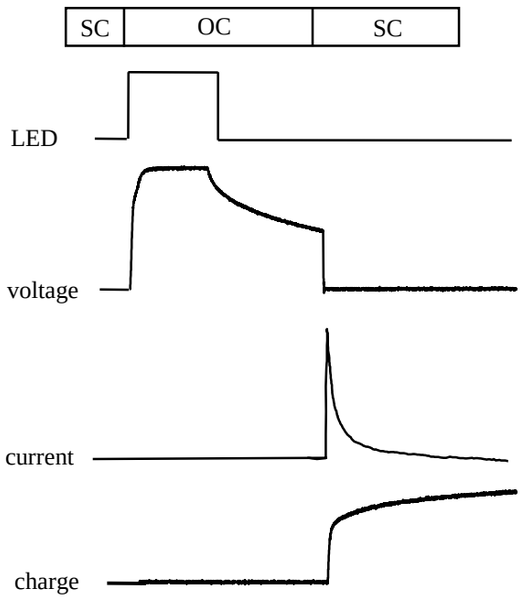
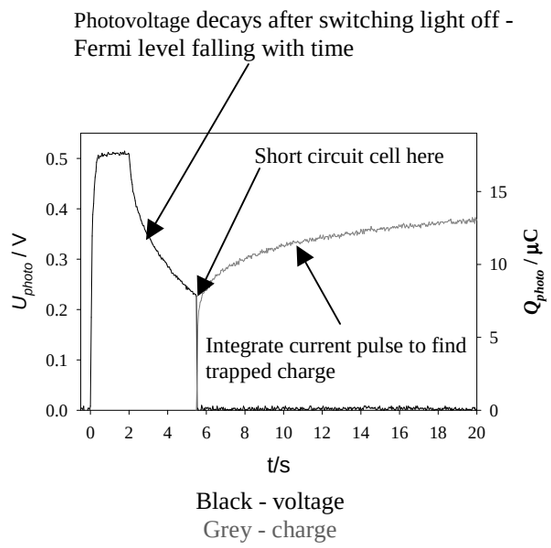


Figure 3. A typical set of results from a charge extraction experiment



Black - voltage
Grey - charge