Electron transfer kinetics in liquid state and solid state dye sensitised solar cells.

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Efficient charge separation at the semiconductor/dye/hole transporting medium interface is an essential feature to the function of dye sensitised photovoltaic cells. The key processes involved in this charge separation, and the competing excited state decay charge recombination reactions are illustrated in figure 1.

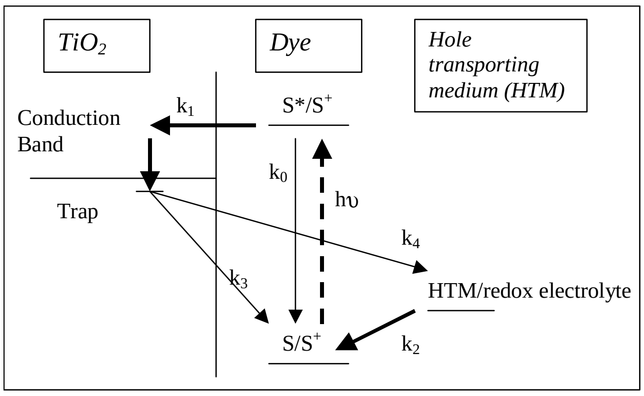

Fig.1 Electron transfer kinetics at the TiO_2 / dye / HTM interface, including excited state decay to ground (k_0), electron injection and trapping (k_1), dye cation rereduction by liquid or solid state hole transporting media (k_3) and charge recombination between electrons in the TiO_2 and dye cations (k_3) or oxidised HTM/redox electrolyte (k_4).

Transient optical spectroscopies have been employed to determine the rates of these competing reactions on timescales from <100 fs to >100 ms[1-3]. The aim of this research is to elucidate the kinetic competition between these processes, which controls the charge separation efficiency as a function of the composition of the interface and the operating conditions of the device.

In this paper we will focus on the back electron transfer reaction k_4 in both liquid and solid state dye sensitised solar cells. We have employed a range of different hole transporting media including liquid electrolytes and molecule hole transporting materials. Typical recombination data for a I_2/I^- liquid electrolyte are shown in figure 2. Issues that will be addressed will include:

- The reaction order of with respect to iodine, iodide and electron concentrations
- The reaction mechanism and intermediates
- The role of ionic screening and physical barrier layers in controlling recombination dynamics in both liquid electrolyte and solid state devices.

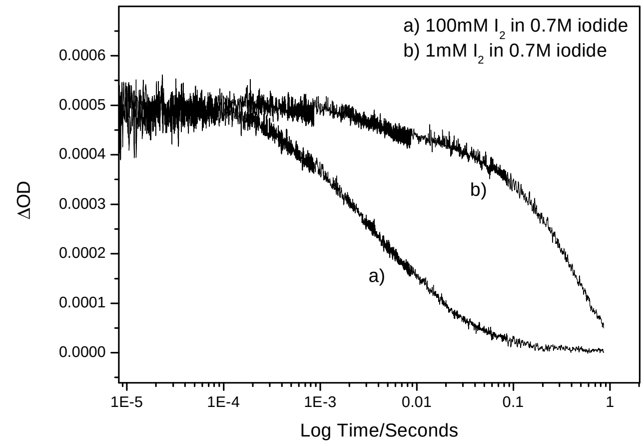

Fig.2 transient absorption decay of electrons in the presence of the I^-/I_3^- redox couple represented with $\log_{10}$ time. Decays a) and b) were recorded for I_2 concentrations of 100 and 1mM respectively.

References

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