Strategies to overcome fast electron-hole recombination in dye-sensitized photoanodes

Valeria Saavedra Becerril[1], Elin Sundin[1], Mokhtar Mapar[2], Daniele Franchi[3], Maria Abrahamsson [1]

[1] Chalmers University of Technology, Department of Chemistry and Chemical Engineering, [2]Department of Physics. Gothenburg, Sweden. [3]Departimento di Chimica "Ugo Schiff", Universita degli Studi di Firenze, Italy.

E-mail: valeria.saavedra@chalmers.se

Dye sensitized photoelectrosynthesis cells (DSPECs) are recently gaining more attention as a promising approach to artificial photosynthesis. Although significant progress has been made in understanding and demonstrating the different functioning principles of these devices, efficiencies of solar to chemical energy conversion remain low due to the fast competing reaction of electron-hole recombination at the photoanode interface.[1] Therefore, it is of importance to dedicate effort in finding new strategies for overcoming this detrimental process.

Here we present recent results from our group from different projects which aim to increase the lifetime of the charge separated state at dye-sensitized mesoporous metal oxides. In the first approach we have used pure ionic liquids to create local charge compensation at the dye-semiconductor interface and we demonstrate that this results in the desired effect (see Figure 1).[2] We showed that this effect is dependent on the dye structure. While back electron-transfer rates were decreased by up to a factor of four in D35/TiO_2 and $[Ru(dcb)_3]Cl_2$/TiO_2 thin films, the rates remained unaffected in N3/TiO_2 films. In a second approach, we have designed a dye-sensitized mesoporous SnO_2-TiO_2 photoanode in which the lifetime of the CSS can be increased by several orders of magnitude compared to SnO_2 and TiO_2 alone, without the need of fabricating core-shell structured particles.

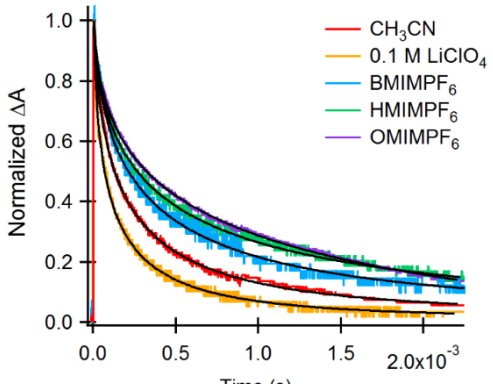

Figure 1. Normalized individual traces and corresponding fits to a KWW model measured by single-wavelength transient absorption (750 nm detection) of D35-TiO_2 thin films upon addition of different electrolytes.

Funding: Swedish research council VR

Acknowledgement: We thank all the contributors to this project(s) and the Swedish research council VR

References:

[1] Brennaman, M. K.; Dillon, R. J.; Alibabaei, L.; Gish, M. K.; Dares, C. J.; Ashford, D. L.; House, R. L.; Meyer, G. J.; Papanikolas, J. M.; Meyer, T. J., *JACS*, **2016**, 138 (40), 13085

[2] Saavedra, B. V.; Franchi, D.; Abrahamsson, M. *J Phys Chem C*, 120 (36), 20016