

# Dye-multilayer semiconductor nanostructures

P.K.D. Duleepa P. Pitigala, M.K. Indika Senevirathna,  
V.P. Susira Perera, Kirthi Tennakone \*

*Institute of Fundamental Studies, Hantana, Kandy, Sri Lanka*

Received 16 September 2004; accepted after revision 6 July 2005

Available online 07 October 2005

---

## Abstract

Broadening of the spectral response of dye-sensitized semiconductor devices is one of the major issues confronting practical application of dye-sensitization. It is the main factor limiting the energy conversion efficiencies of dye-sensitized solar cells. Synthesis of dyes with broader spectral response has been attempted as a possible strategy. The other method is to adopt more than one pigment. However, the straightforward ways of doing this has been unsuccessful owing to the quenching and the insulating effect of thick dye layers composed of many components. Again, if several dyes are homogeneously dispersed over the nanocrystalline surface at sub-monolayer coverage of each dye, the problem of quenching and insulation may be avoided. Here we face another constraint. In order to achieve full absorption at the peak wavelength of each dye, the film thickness needs to increase, the limit for which is the diffusion length of carriers in the nanocrystalline matrix. We have found some ways of circumventing the above difficulties and construct model solar cells sensitized with more than one pigment. A solar cell of the configuration  $n\text{-TiO}_2/D_1\text{-}D_2/p\text{-CuSCN}$  was constructed, where  $D_1$  = an ionic dye bonded to the  $\text{TiO}_2$  surface and  $D_2$  = ionic dye of opposite charge, electrostatically bonded to  $D_1$ . In another cell, two dyes  $D_1$  and  $D_2$  are used form the heterostructure  $n\text{-TiO}_2/D_1/S/D_2/p\text{-CuSCN}$ , where S is an ultra-thin barrier of a high band gap semiconductor. Each of the above double dye-systems showed efficiencies above the equivalent single dye systems. These methods can also be extended to liquids cells. A better suppression of electron-hole recombination was found to be an additional advantage of multiple dye systems. The mechanisms of operation of these devices via electron or energy transfer or electron tunneling will be discussed. *To cite this article: P.K.D. Duleepa P. Pitigala et al., C. R. Chimie 9 (2006).*

© 2005 Académie des sciences. Published by Elsevier SAS. All rights reserved.