Development of NIR Dyes & Control of Dye Adsorption Behavior in Dye-Sensitized Solar Cells

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Dye-sensitized solar cells (DSSCs) have attracted the global attentions owing to their lower cost, environment friendly fabrication process and interesting working principle mimicking natural photosynthesis along with esthetic and colorful design aspects. In spite of efficient photon harvesting by potential sensitizers below 750 nm in DSSCs surpassing the efficiency beyond 11 % is undoubtedly impressive. A panchromatic photon harvesting in the wide wavelength region (visible to infra-red) is highly desired to attain the high photoconversion efficiency. A perusal of the photon harvesting exhibited by many efficient sensitizers used for DSSCs reveals that there is a need for development of novel sensitizers with sharp light absorption and photon harvesting in the NIR-IR wavelength region. With the judicious selection of suitable donor moieties, we designed unsymmetrical squaraine dyes having capability of light absorption from far-red to NIR region[1]. We have recently reported that the implementation of dye-double layer architecture for dye adsorption leads to the synergistic photon harvesting from both of the dyes[2]. Since dyes play its pivotal role in the actual photon harvesting, investigations pertaining to their adsorption behavior on the nanoporous oxide semiconductor like TiO_2 is highly important especially in the case of utilization of two or more dyes. Recently we have demonstrated that adsorption of two dyes in dye bi-layer architecture exhibits enhanced photon harvesting as compared adsorption form their dye cocktail solution having random dye distribution[3]. We have also shown that it is also possible to attain bi-layer dye adsorption from the dye cocktail by judicious selection of the dyes and proposed their mechanism also[4]. In my talk, I would like to discuss about the development NIR dyes in the light of molecular orbital calculations, photophysical investigations[4] and their implementation for the fabrication of DSSCs. At the same time, I would also like to discuss about the adsorption behavior of the sensitizers on the nanoporous TiO_2 and their implication on the photon harvesting behavior.

1. S. S. Pandey et al, Tetrahedron, 69, 2633 (2013).
2. F. Inakazu et al, Applied Physics Letters, 93, 093304 (2008).
3. Y. Noma et. al, Japanese Journal of Applied physics, 48, 020213 (2009).
4. Y. Ogomi et al, Thin Solid Films; 519, 1087 (2010).
5. G. de Miguel et al, Journal of Physical Chemistry C, 116, 22157 (2012).