

Shedding Light on Organics: Plasmons, Spacers, and More

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Organic photovoltaic cells are generally thin layer systems. In such systems one cannot just assume Lambert-Beer's law for optical absorption, but one has to take into account the coherence of light and therefore interference effects occurring because of strongly reflecting layers such as metal electrodes or layers with strong refractive index contrast. In this talk I will discuss some strategies to optimize and control the interaction of the organics with the incoming light. The first strategies involve management

of the dielectric stack in order to optimize the placement of the optical electrical field in the right spots. Consideration of the individual layer thicknesses together with recombination and transport kinetics leads to optimal values. Another strategy involves surface plasmons. Surface plasmons are collective oscillations of conduction electrons in metal nanostructures that localize light in the vicinity of the nanostructured surfaces or strongly scatter light. Such surface plasmons can be used to localize incoming light into active layers of the cell, increasing its optical absorption and therefore its photocurrent.

In the last part of the talk, a new strategy to manipulate the light/matter interaction will be discussed. This involves quantum mechanical hybridization of excitonic states

with surface plasmons. Such interactions allow for the control of excited state pathways and therefore of energy flow. An example is shown in Figure 1.¹ The Figure illustrates the change in triplet generation kinetics in pentacene in the presence of a silver nanohole array. The surface plasmon causes the yield of triplets to increase strongly and its dynamics to change considerably. Such changes of excited state dynamics can potentially be used to drive third-generation processes such as singlet fission and multiple exciton generation. Learning to control the excited state dynamics better can therefore lead to large advances in solar conversion.

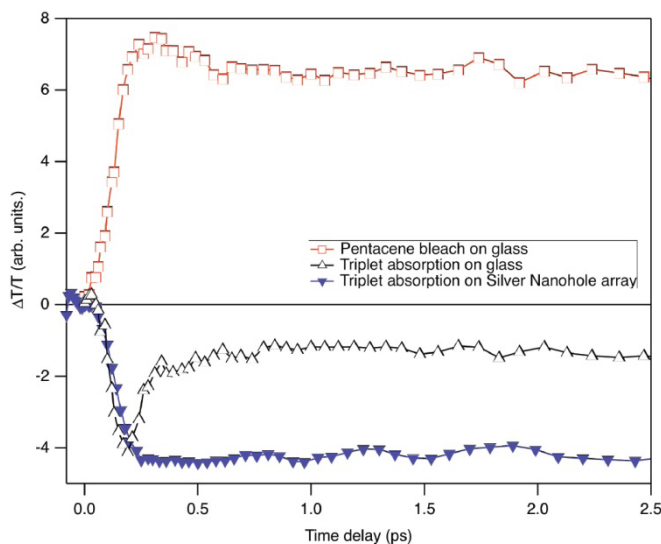


Fig. 1. Ultrafast excited state dynamics of pentacene on glass and on a silver nanohole array.

[1] J. C. Johnson, T. H. Reilly III, A. C. Kanarr, and J. van de lagemaat. *J. Phys. Chem. C* (2009) vol. 113 (16) pp. 6871-6877.