Management of hot photons in organic absorbers

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Hot carrier solar cells have attracted interest for many years.[1] Although no working exemplars yet exist the challenges to overcome have become clearer, with substantial research effort focusing, in particular, on inorganic semiconductors (including quantum wells)[2] and more recently, also on perovskites.[3] In this paper we propose a novel strategy based on organic absorbers. Combined with photon management structures similar to photonic fluorescent collectors these absorbers bear the promise to enhance the efficiency of the complete photovoltaic devices. We will present a method for characterisation of fluorescent collectors by evaluating the chemical potential and temperature of the emitted fluorescence photon flux, by analysing the spectra of hot photon flux escaping from the top, as well as the flux guided towards edge of the collector. Our results demonstrate temperatures of the emitted photon flux higher (above 400 K) than the ambient temperature, indicating the presence of "hot photons". Similar to the concept of hot carriers solar cells, excess thermal energy carried by hot photons can be exploited to increase the chemical potential of the photon flux which is closely related to the open-circuit voltage of the solar cell. Furthermore, we propose a design of photonic structure based on polymer DBRs in order to improve capture of hot photon flux and to enhance light-dye interaction.

[1] R. Ross and A. Nozik, J. Appl. Phys. 53, 3813 (1982)

[2] See, for example, D. König et al, Physica E, 42, 2862 (2010)

[3] H. Fang et al, Nat. Commun. 9, 243 (2018)