

## Triplet-Triplet Annihilation-based Photon Upconversion Using All-organic Polycyclic Aromatic Donor and Acceptor Chromophores

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Photon upconversion (UC) is a non-linear photophysical process allowing to transform low-energy radiation into higher energy photons. Triplet-triplet annihilation-based UC (TTA-UC) requires a light-harvesting triplet chromophore (donor) that is be used to sensitize a fluorophore (acceptor) via triplet energy transfer (TET). After donor $\rightarrow$ acceptor TET, the formation of metastable triplet species of the acceptor chromophore will then undergo self-quenching to generate photons of higher energy with respect to the input radiation. Due to recent advances in synthetic chemical science, many research groups have reported a number of organic triplet sensitizers for TTA-UC research with various degrees of success. From our perspective, we have been exploring donor and acceptor polycyclic aromatics, which are structurally similar & complementary in a such a way that the kinetics of the TET competes with the rate of molecular diffusion: the donor and acceptor chromophores can form supramolecular  $\pi$ - $\pi$  aggregates, that favor ultra-fast TET. In our adventure, we developed novel organic quinoidal naphthalene triplet sensitizers that can efficiently harvest green photons and then transfer the triplet energy to polycyclic aromatic acceptors such as perylene. Consequently, the annihilation of two perylene triplet excitons produces blue photoluminescence with moderate quantum yield. The interactions of the triplet energy donor and acceptor chromophores was deciphered by Stern-Volmer quenching study, where the kinetics of the energy transfer process was found to be faster than the rate of molecular diffusion in solution. The unexpected kinetics/dynamics was attributed to the formation of supramolecular  $\pi$ - $\pi$  aggregates of the donor and acceptor molecular units; this result is in agreement with our initial hypothesis. Furthermore, quenching studies of the triplet transient of the donor by perylene were performed by transient absorption techniques. This method revealed that the kinetics of  $T_1 \rightarrow T_n$  for the donor species ( $\tau = 1.4 \mu\text{s}$ ) was one order of magnitude reduced ( $\tau = 0.17 \mu\text{s}$ ) in the presence of perylene. We also demonstrated that incident light powers in the microwatt regime were sufficient to perform photon upconversion using this set of molecular donor-acceptor system.

This poster will survey all-organic donor and acceptor chromophores that were developed in recent years for TTA-UC research; the presentation will also highlight the synthesis, characterization and photophysics of the light harvesting chromophore reported from our group. Moreover, the mechanism and kinetics of donor $\rightarrow$ acceptor TET will be detailed.

1. S. Shore, J. Li, M. K. Manna, G. P. Wiederkehr, D. J. Gustily, A. Urine, S. Jockos, A. Y. Bogachev and A. J.-L. Ayitou, *J. Org. Chem.*, **2017**, 82, 10167–10173.
2. S. Shore, G. P. Wiederkehr, D. J. Gustily and A. J.-L. Ayitou, *J. Phys. Chem. C*, **2017**, 121, 23377–23382.