

Evidence for enhanced longtime scale molecular fluorescence mediated by graphene

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Abstract

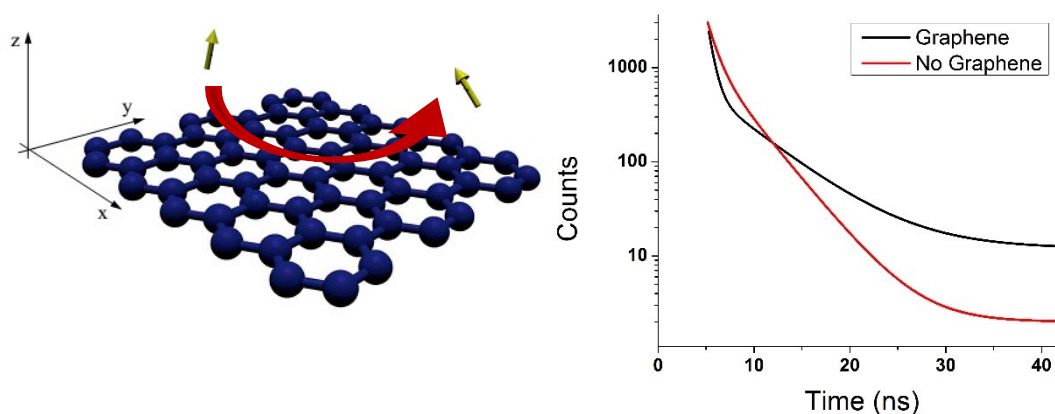
Graphene, being an ultra-thin, strong, high transparency, flexible conductor, has excellent potential for a wide variety of applications[1]. Graphene plasmonics is a new topic[2] that can be explored to manipulate light at nanoscale. For example, it has been predicted that the transfer of energy (FRET) between a donor-acceptor pair in close vicinity to a graphene sheet can be enhanced due to the excitation of plasmons in the graphene sheet[3]. The predicted broadband property of the plasmon enhancement is very advantageous since one can expect large enhancement also in cases where the emission and absorption spectra of the donor and acceptor do not fully overlap.

Fluorescent molecules in close proximity to graphene can efficiently excite graphene plasmons[4], since they provide the large wave vectors, existing in the near-field of the emitters, necessary for graphene plasmon excitation. In this work we show experimentally that the presence of single layer graphene flakes in close proximity to an ensemble of perylene organic dye molecules induces both quenching of the perylene on a fast time scale and an enhanced emission on longer timescales. We take the enhanced emission at later timescales as evidence that these plasmons once excited in the graphene can serve as an energy reservoir which is capable of exciting other molecules at a later time, leading to an extended tail in the fluorescence decay curve of the ensemble. The enhanced fluorescence at long time scales is all the more noteworthy given the initial fast quenching induced by the presence of the graphene.

References

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Figures



A schematic of the excitation transfer between molecular dipoles via the plasmonic waves excited in a nearby graphene sheet (left figure); Fluorescence decays curves for high concentrations of perylene molecules in a thin PMMA film (less than 2 nm) on top of or away from a single layer graphene flake. The increased emission at time scales of several nominal lifetimes of perylene is taken as evidence of the excitation transfer process.