Energy transfer from photosynthetic proteins to graphene and reduced graphene oxide

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Extraordinary optical properties of graphene make this material a great energy acceptor in fluorescence resonance energy transfer (FRET) assemblies. The key requirement of FRET which is spectral overlap between absorption of an acceptor and emission of a donor is met due to the efficient absorption of graphene across the whole visible spectral range.[1] There are two main spectroscopic markers of FRET: shortening of donor fluorescence lifetime and quenching of the donor emission.[2,3]

In this work we examined the energy transfer process to graphene and thermally reduced graphene oxide (rGO). The donors of energy were natural photosynthetic proteins: photosystem I (PSI) from *C. merolae* and Peridinin-Chlorophyll-Protein (PCP) from *Amphidinium carterae*. PCP is a simple light-harvesting complex with a broad excitation range, while PSI is a photosynthetic complex with much higher degree of complexity.[4,5] For both PCP and PSI we studied the dependence of FRET efficiency on excitation energy and thickness of graphene or rGO.

The results show strong fluorescence quenching PSI by graphene, however fluorescence maps for commercial graphene are more homogenous as compared to transferred graphene. In contrast, for PSI on rGO a-few-micron-large islands are observed, which we interpret as a result of different fluorescence quenching by areas with varied number of rGO layers. Similar result was found for PCP, where FRET efficiency was decreasing with increasing number of graphene layers and fluorescence of PCP is also strongly quenched for rGO sample. For both emitters the energy transfer process is affected by the excitation energy.

The results of fluorescence microscopy imaging, both in steady-state and time-resolved domains, indicate clearly that the energy transfer from emitters for graphene and its derivatives is highly sensitive to a number of factors, which substantially distinguishes graphene – based assemblies from classic structures applied previously for studying the dynamics of the energy transfer.

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