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Effects of graphene oxide and reduced graphene oxide on the energy storage capacity of a short-chain dyad. A comparative study with the pristine dyad

Somnath Paul[a], Soumi Mondal[a], Ishani Mitra[b], Debmalya Halder[a], Subrata Das[c], Mithu Saha[d], Madhurima Chakraborty[e], Pabitra K Chakrabarti[f], Bibhuti Bhushan Show[g], Tapan Ganguly[a,*]

[a] School of Laser Science and Engineering, Jadavpur University, Jadavpur, Kolkata 700032, India
[b] Department of Physics, Jadavpur University, Kolkata 700032, India
[c] Department of Central Scientific Services, Indian Association for the Cultivation of Science, Jadavpur, Kolkata 700032, India
[d] Goalpara College, Goalapara, Assam, India
[e] Department of Biochemistry, West Bengal State University, (Barasat, North 24 Parganas), Kolkata 700 126 India
[f] Department of Physics, University of Burdwan, Burdwan, India
[g] Department of Chemistry, Jadavpur University, Kolkata 700032, India

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ABSTRACT

Steady state and time resolved spectroscopic investigations on a pristine short-chain dyad (E)-(((9H-fluorene-2-yl)imino)methyl)-N,Ndimethylaniline (NNDMBF) and its nanocomposite forms with Graphene oxide (GO) as well as reduced Graphene oxide (RGO) were made in order to develop efficient light energy converters. To the best of our knowledge, it appears to be the first time when by using the techniques of fluorescence lifetimes along with femtosecond transient absorption spectroscopic measurements it has been demonstrated that graphene nanocomposite dyads could form much larger charge-separated yield ($\varphi_R \sim 0.28$) coupled with slower energy wasting charge recombination rate processes ($k_{CR} \sim 10^9 s^{-1}$) relative to the pristine dyad ($\varphi_R \sim 0.02$, $k_{CR} \sim 10^{11} s^{-1}$). This shows GO (and also RGO) plays significant role in designing stable light energy converter as well as light or energy storage devices when combined with the pristine dyad.

1. Introduction

Investigations on photoswitchable short-chain dyads [1–8] are gradually becoming interesting topics of modern research due to their wide applications in molecular electronics, building of components of photovoltaic cells and artificial light energy converters, optical data storage devices etc. Besides, miniaturization of structures in nanoscale dimension has supported nano platform for prospective research. Also, the technological advantages of nanoparticles for its various applications are its good stability, efficient carrier capacity and possibility of numerous routes of administration [9–15]. Moreover, among various nanomolecules members of carbon nanofamily have received noticeable attention. Lately, various forms of graphite, that is chemically modified by Hummer's method and altered through surface modification in different forms have been frequently used for wide-range of applications especially for biomedical application [14], water treatment [16], anti-UV application [17], anti-corrosion, thermo/mechanical [18–21], fire retardancy [22] and many more. Furthermore, oxidation of graphene sheets to graphene oxide and chemical surface functionalization via different organic/inorganic compounds are two common practical/efficient strategies to customize and enhance the usage of graphene for numerous applications. Also, different strategies for modification/reduction of GO have attracted huge attention over the years [23–26].

Moreover, recent studies by steady state and time resolved spectroscopic techniques demonstrate that when the short-chain dyads combine with nanoparticles of noble metals such as silver, gold, gold/silver core-shell nanocomposite systems [2] and carbon quantum dots [1] they exhibit efficient artificial light energy conversion materials. Investigations with the dyad MNTMA, where methoxynaphthalene donor is attached with the electron accep-

* Corresponding author.
E-mail address: tapcla@rediffmail.com (T. Ganguly).

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