

Supramolecular Assemblies of Carbon Nanohorns and Porphyrin for Photovoltaic Devices

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Carbon Nanohorns^[1] (CNHs) represent a new type of nanostructured carbon-based material. One of the merits of CNHs different from other carbonaceous materials is a high purity due to the absence of any metal nano-particles. Thus, CNHs have attracted a great deal of attention in several fields as optoelectronic applications.^[2]

Combination of covalent and non-covalent functionalization of CNHs is particularly promising for building donor–acceptor nanohybrids. Among various non-covalent methodologies reported, self-assembly by using an ammonium ion-crown ether interaction is regarded as one of the most powerful methods. Porphyrin / Fullerene based donor–acceptor supramolecular systems involving crown ether-ammonium interactions have been prepared for probing photo-induced electron processes. This concept has been extended to build porphyrin / SWCNT donor–acceptor nanohybrids, and occurrence of photo-induced charge separation processes is clearly demonstrated.^[3]

Herein, we describe a supramolecular assembly of CNH covalently bonded with amino groups via spacer (sp) (CNH-sp-NH₃⁺), which is included in crown-ether appending porphyrin (Crown-ZnP). Nanohybrid CNH-sp-NH₃⁺ and the supramolecular assembly CNH-sp-NH₃⁺;Crown-ZnP were characterized by means of several techniques as HR-TEM, TGA, XPS, Raman, FT-IR and UV-vis spectroscopies. Photoinduced electron-transfer processes of the nanohybrids are confirmed on combining the time-resolved absorption and fluorescence measurements, in addition to the accumulation of viologen cation radical in solution with steady-light illumination. The efficiency of this system in photovoltaic solar cells is shown.

References:

[1] Iijima, S.; Yudasaka, M.; Yamada, R.; Bandow, S.; Suenaga, K.; Kokai, F.; Takahashi, K. *Chem. Phys. Lett.*, 309 (1999), 165.

[2] (a) Iijima, S. *Physica B*, 23 (2002), 1. (b) Fan, J.; Yudasaka, M.; Kasuya, Y.; Kasuya, D.; Iijima, S. *Chem. Phys. Lett.*, 397 (2004), 5. (c) Murata, K.; Hashimoto, A.; Yudasaka, M.;

Kasuya, D.; Kaneko, K.; Iijima, S. *Adv. Mater.* 16 (2004), 1520. (d) Murakami, H.; Ajima, K.; Miyawaki, J.; Yudasaka, M.; Iijima, S.; Shiba, K. *Mol. Pharm.* 1 (2004), 399. (e) Sandanayaka, A. S. D.; Pagona, G.; Tagmatarchis, N.; Yudasaka, M.; Iijima, S.; Araki, Y.; Ito, O. *J. Mater. Chem.* 17 (2007), 2540. (f) Cioffi, C.; Campidelli, S.; Sooambar, C.; Marcaccio, M.; Marcolongo, G.; Meneghetti, M. S.; Paolucci, D.; Paolucci, F.; Ehli, C.; Rahman, A.; G. M.; Sgobba, V.; Guldi, D. M.; Prato, M. *J. Am. Chem. Soc.* 129 (2007), 3938. (g) Sandanayaka, A. S. D.; Ito, O.; Tanaka, T.; Isobe, H.; Nakamura, E.; Yudasaka, M.; Iijima, S. *New J. Chem.* 33 (2009), 2261.

[3] D'Souza, F.; Ito, O. *Chem. Commun.* (2009), 4913.

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