Photosensitized Hydrogen Evolution from Water Using Coaxial Nanohybrid Based on SWCNTs

Yutaka Takaguchi*, Yukari Sasada, Takaaki Wada, Tomoyuki Tajima
Graduate School of Environmental and Life Science, Okayama University
Tsushima-Naka 3-1-1, Kitaku, Okayama 700-8530, JAPAN

Photocatalytic hydrogen generation has been a challenging topic for realization of the storage and conversion of solar energy. Recently, Jiang and co-workers reported that a poly(phenyleneethynylene) conjugated backbone wrapped with a poly(benzyl ether) dendrimer framework bearing charged exterior surfaces shows amazing high activity, i.e., the quantum yield for the hydrogen evolution reaches 0.26 upon irradiation with a light of wavelength 410 - 430 nm.[1] From this point of view, the construction of highly ordered photofunctional interface should be quite effective to improve the photocatalytic activity of organic systems. We reported photoinduced electron transfer systems consisting of fullerene and/or SWCNTs.[2] Especially, dendritic dispersants, anthryl dendrons and fullerodendrons, were very effective to disperse the SWCNTs via the formation of supramolecular nanocomposites,[3] of which charge-separated states were observed under visible light irradiation.[2b,d] In particular, the charge-separated state of SWCNT/fullerodendron is capable to migrate the electron to methyl viologen (MV^{2+}) yielding $MV^{\bullet+}$ as an electron pool. Because dendritic wedges of the SWCNT/fullerodendron supramolecular nanocomposites are very useful to introduce an inorganic shell, we have succeeded to produce SWCNT/fullerodendron/SiO_2 coaxial nanohybrid that can act as an photosensitizer to generate hydrogen from water (Fig. 1).[4] It is notable that the quantum yield of hydrogen evolution using the coaxial nanohybrid is 0.31 upon a visible light (λ = 450 nm) irradiation.

This paper describes the chemical modification of SWCNT/fullerodendron supramolecular nanocomposite and its photocatalitic activity.

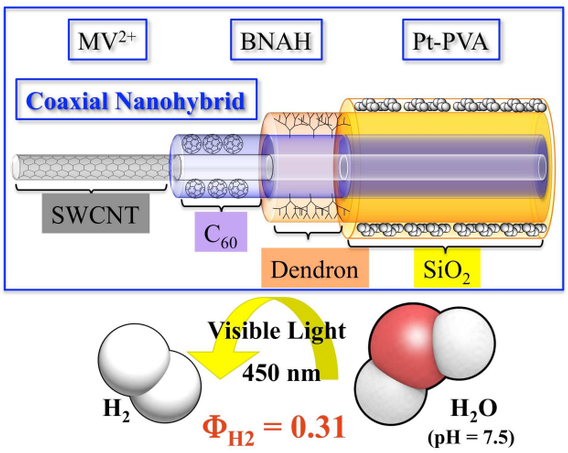

Fig. 1. Schematic illustration of SWCNT/fullerodendron/SiO_2 coaxial nanohybrid and its photocatalytic hydrogen evolution reaction.

References

1 D.-L. Jiang, C.-K. Choi, K. Honda, W.-S. Li, T. Yuzawa, T. Aida, *J. Am. Chem. Soc.* **2004**, 126, 12084.
2 a) A. S. D. Sandanayaka, H. Zhang, Y. Takaguchi, Y. Sako, M. Tamura, Y. Araki, O. Ito, *Chem. Commun.* **2005**, 5160; b) A. S. D. Sandanayaka, Y. Takaguchi, T. Uchida, Y. Sako, Y. Morimoto, Y. Araki, O. Ito, *Chem. Lett.* **2006**, 35, 1188; c) Y. Araki, R. Kunieda, M. Fujitsuka, O. Ito, J. Motoyoshiya, H. Aoyama, Y. Takaguchi, *C. R. Chim.* **2006**, 9, 1014; d) A. S. D. Sandanayaka, Y. Takaguchi, Y. Sako, M. Tamura, O. Ito, *Adv. Sci. Lett.* **2010**, 3, 353.
3 Y. Takaguchi, M. Tamura, Y. Sako, Y. Yanagimoto, S. Tsuboi, T. Uchida, K. Shimamura, S. Kimura, T. Wakahara, Y. Maeda, T. Akasaka, *Chem. Lett.* **2005**, 34, 1608.
4 T. Tajima, W. Sakata, T. Wada, A. Tsutsui, S. Nishimoto, M. Miyake, Y. Takaguchi, *Adv. Materials* **2011**, 23, 5750.