Organic Nanocrystals as Potential Water-Splitting Photocatalyst

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There is no doubt that hydrogen (H_2) fuel will soon replace the traditional fossil fuel as a new form of energy storage. Electricity and water can be produced when H_2 react with oxygen. Honda-Fujishima [1] reported that an inorganic oxide-based semiconductor such as TiO_2 has the ability to produce H_2 directly from the solar irradiation. However, these catalysts operate with ultraviolet light, region, which would account for only 4% of the solar energy. Despite great efforts over past decades to develop photocatalysts that can yield high reactivity under visible light region, the efficiency and the stability of modified TiO_2 still remain low. Although oxide-based semiconductors have been widely explored, photocatalytic activity studies of organic materials are so far scarce. In this particular work, an original approach has been taken. An organic polymer nanocrystal (NCs), polydiacetylene(PDA) has been demonstrated for as a visible light-active photocatalyst, owing to its narrow, and suitable band gap (2.33 eV) for H_2 evolution reaction [2]. We demonstrated the high efficiency of PDA NCs for the photodegradation reaction of an organic dye, where the photodegradation rate of Rhodamine B (RhB) is far superior to TiO_2 in both Visible and UV-Vis irradiations (Fig.1). We also confirmed the enhanced photocatalytic efficiency by performing a surface modification of PDA NCs with noble metal NPs using polydopamine (Dopa) as a binder. The results suggested that Dopa could function not only as a binding layer, but also as a kind of photosensitizer for PDA NCs, where noble metal nanoparticles assist help increasing the reaction sites and absorbing photons. In addition, recent experiments have indicated good recyclability of PDA NCs as well as the great thermal stability. The photodegradation mechanism of the PDA and PDA-Ag has been proposed as well. Our finding could advance the development of H_2 generation system using organics and so on in the near future.

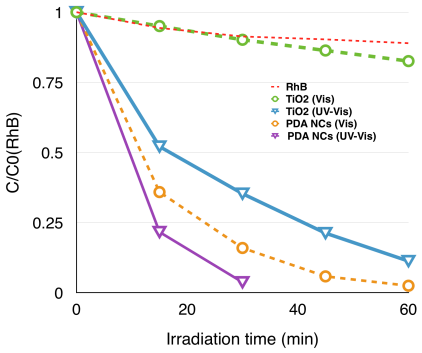

Fig. 1 Comparative photocatalytic activity of PDA NCs, and TiO_2 under Vis, and UV-Vis irradiations.

[ACKNOWLEDGEMENT]
We would like to thank Dr. Yosuke Miyashita, Fuji Film Co., for useful discussions and advice.

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