Proceedings of the 5th World Congress on New Technologies (NewTech'19)
Lisbon, Portugal – August, 2019
Paper No. ICNFA 123
DOI: 10.11159/icnfa19.123

Fabrication and Visible Light Photocatalytic Activities of TiO_2 Nanomaterials Incorporated with Tin(IV) Porphyrins

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Extended Abstract

Photocatalytic processes using TiO_2 as photocatalyst have been introduced in the seventies. However, despite lots of advantages, TiO_2 must be excited in the UV region, which means that it can absorb only 3% of solar energy it receives. The majority of solar energy is concentrated in the visible region. Therefore, a photocatalyst that is active under visible light is of paramount importance as an essential element of solar photoenergy utilization. A variety of approaches has been attempted in search of visible light active materials. Porphyrins and metalloporphyrins have been widely investigated for their photochemical activity for various applications such as environmental photocatalysis, hydrogen production, and solar cell. The electrochemical potentials for the porphyrin ring being the redox center is readily dependent on the kind of central metal ions. Among a series of metalloporphyrins, tin(IV)-porphyrin has a strong oxidative capacity (porphyrin ring reduced easily) owing to the high charge on tin(IV) and the excited tin-porphyrin exhibits a high activity for the photooxidation of organic compounds under visible light [1]. We have interests in the photocatalysts based on tin-porphyrin with strong visible light absorption as an efficient visible light photocatalyst for an environmental remediation [2-4] and H_2 production [5,6]. We here present TiO_2 hybrid nanomaterials incorporated with tin(IV) porphyrins exhibiting visible light activities: (i) Tin(IV) porphyrins incorporated-TiO_2 nanotubes with 152 m^2/g of surface area and 0.44 cm^3/g of porosity showing visible-light-activated photocatalytic production of H_2. (ii) A ternary hybrid material of semiconductor/polymer/porphyrin in which the surface of TiO_2 particles coated with perfluorosulfonate polymer (Nafion®) binds water-soluble cationic tin(IV) porphyrins within the Nafion layer through electrostatic attraction. H_2 evolution activity in this ternary hybrid material was estimated to be 1.5 times higher than that in TiO_2-porphyrin without Nafion®.

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