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Article / Book Information

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（博士課程）
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論 文 要 旨
THESIS SUMMARY

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学籍番号： Student ID Number			指導教員（主）： Academic Advisor(main)	Nagai Keiji	
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The development of a photocatalyst system working under visible light irradiation is indispensable from the viewpoint of efficient solar energy utilization. In this thesis, I discussed the visible-light active photocatalyst of p/n junction like metallophthalocyanine/fullerene nanoparticles fabricated by wet process based visible-light-responsive have been developed, focusing on the structure, photoelectrochemical and the photocatalytic behavior of the nanoparticles. The cobalt phthalocyanine/fullerene (CoPc/C_{60}) nanoparticles showed the p/n junction like behavior and it was suggested from the photoelectrochemical studies. The photocatalytic characteristics were confirmed from the oxidation of organic pollutants under visible light illumination.

In Chapter I, the overview of the fundamental aspect and application of semiconductor photocatalysis, further the requirements and availability of visible light active photocatalyst was described, where its photocatalytic studies was focused on the degradation of organic pollutants. Through the previously reported visible light photocatalyst, p/n junction like nanoparticles based on organic semiconductor is not explored well and resulting in a finding out the uniqueness of the new p/n junction like cobalt based semiconductor nanoparticles acting as low-cost based nanoparticles, where the commercial usage of the photocatalyst is applicable. In Chapter 2, I described the investigation on the structure and photoelectrochemical studies on the nanoparticles composite composed of C_{60} and VOPc were fabricated by a reprecipitation process. The XRD measurements indicate that the VOPc/C_{60} composite nanoparticles do not retain the diffraction peak neither from C_{60} nor VOPc. The photoelectrochemical properties of the composite are higher than those of C_{60} and VOPc particles and it exhibits the organic n/p junction like behavior. In chapter-3, I described the investigation on the structure and photocatalytic properties of a nanoparticle composite composed of C_{60} and CoPc prepared by a reprecipitation process, in which a mixed n-methyl-2-pyrrolidone solution of C_{60} and CoPc was injected into water. The photocatalyst is having a biphasic structure and likely to have p/n junction-like characteristics. The photocatalytic results indicate that the composite C_{60}/CoPc nanoparticles oxidize the various organic substrates (trimethylamine, 2-mercaptoethanol and acetaldehyde) and act as a photocatalyst for photooxidation reaction. External quantum efficiency of the photocatalysis suggests an autoxidation behavior of organic substrates after the partial photo oxidation, which was one of the causes of the superior photocatalytic activity for oxidation reactions. The external quantum efficiency of CO_2 generation for one hole oxidation was estimated to be 0.06 for trimethylamine. This work could be explored for the fabrication of less expensive biphasic cobalt based p-n junction like nanoparticles and could be considered as a potential candidate for oxidation of organic pollutants. In chapter 4, I described investigation on the photoelectrochemical properties of a nanoparticle composite composed of C_{60} and CoPc prepared by a reprecipitation process. The photocatalyst is having a biphasic structure and likely to have p/n junction like characteristics. The photoelectrochemical properties of the composite similar to those of the vapor-deposited bilayer of C_{60} and CoPc with a p/n junction. The internal quantum efficiency (IQE) value of composite particles prepared by electrophoretic deposition method was estimated to be 4.6% at 500 nm. The nanoparticle orientation on conducting substrate was controlled by electrophoretic deposition method and it's verified by the photoelectrochemical behavior in the presence of electron donor/acceptor respectively. The photoelectrochemical studies confirm the superior photoanodic current behavior of CoPc/C_{60} than that of the AlPc/C_{60}. In Chapter 5, I described the investigation on the photoelectrode characteristics of p/n junction like characteristics of the acid/base treatment method. The photoelectrode is having a biphasic structure and likely to have p/n junction like characteristics. The photoelectrochemical properties of the composite similar to those of the vapor-deposited bilayer of C_{60} and CoPc with a p/n junction. The IQE value of photoanodic current for composite particles prepared by the acid treatment method was estimated to be 1 % at 420 nm and IQE value of photocathodic current prepared by base treatment method was estimated to be 1.2 % at 600 nm. The acid/base treatment method is utilized to orient the nanoparticles and confirmed by photoelectrochemical evidence. The Photoelectrochemical studies confirm the superior activity of CoPc/C_{60} than that of CoPc or C_{60} characteristics. Finally, I summarized my studies about the biphasic p/n junction like composite nanoparticles in chapter 6.

A series of metallophthalocyanine/fullerene nanoparticles was fabricated based on wet chemical process, which make it possible to fabricate the p/n junction like nanoparticle in the range of < 50 nm to my best knowledge. This process provides not only a simple synthetic process, but also its internal quantum efficiency of electrophoretic deposition technique (4.6 %) for photoanodic current is comparable with the dry process (7 %). Among them, new p-n junction-like cobalt based catalyst showed superior photocatalytic activity than AlPc/C_{60} nanoparticles and the reason behinds the superiority was explained on the basis of the photoelectrochemistry. The nanoparticle orientation was controlled by electrophoretic deposition technique on the conducting substrates. The present photocatalyst was successfully demonstrated to work under low light illumination (< 1mW/cm^2), which makes the present photocatalyst applicable to interior applications.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 2 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 2 copies of 800 Words (English).