【Grant-in-Aid for Scientific Research (S)】
Science and Engineering (Engineering)

Title of Project : Design and Applications of single-Site Photocatalysts Using Nano-Space

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Research Project Number : 26220911 Researcher Number : 40200688
Research Area : Engineering, Catalysis and Materials Chemistry
Keyword : Catalyst design, Photocatalysts, Single-site, Nano-pores, Nano-metal, Plasmon

【Purpose and Background of the Research】

The unique and fascinating properties of silica-based zeolites and mesoporous silica have opened up new possibilities for many chemical and physical processes. Because they are transparent to UV-visible light, silica materials have often been functionalized with elements such as Ti, Cr, V, Mo, and W. These well-defined active centers have shown to be highly dispersed at the atomic level in a tetrahedral-coordination geometry and have been named as "single-site photocatalysts". The light irradiation of single-site photocatalysts induces the charge transfer excited states exhibiting unique activity in the various photocatalytic reactions.

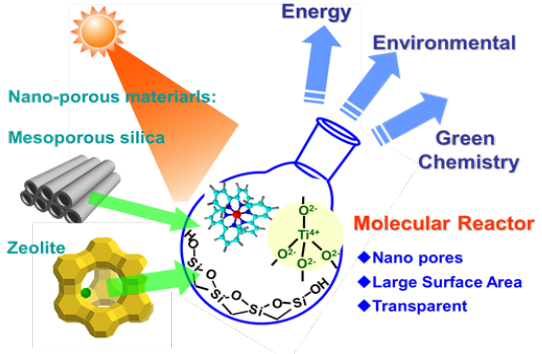

Figure 1 Design and applications of single-site photocatalysts using nanoporous materials.

These single-site photocatalysts not only can promote photocatalytic reactions but also can be utilized to synthesis of functional materials. The nano-sized metal catalyst and visible-light sensitive photocatalyst can be synthesized with the single-site photocatalyst. The transparent mesoporous silica thin film with single-site photocatalyst generates the superhydrophilic surface. In this study, applications of single-site photocatalysts to design of unique functional materials will be made.

【Research Methods】

The single-sites can be implanted into silica matrices by various techniques including hydrothermal synthesis, sol–gel method and chemical vapor deposition, etc. By the hybrid of nano-space and single-site photocatalysts, following studies on design of functional materials can be carried out. 1) Design of visible-light sensitive single-site photocatalyst, 2) Design and utilization of 3D-porous structures and core-shell structures, 3) Design of hydrophobic porous structures, 4) Design of nano-sized metal catalyst, 5) Design of one-pot reaction, 6) Design of porous thin film with superhydrophilic and superhydrophobic surface, 7) Design of unique photofunctional metal complex.

【Expected Research Achievements and Scientific Significance】

The single-site photocatalysts in nano-space can be utilized to design of functional materials. The hybrid of single-site moieties and photofunctional metal complex should perform as visible-light sensitive photocatalyst for artificial photosynthesis such as water splitting H_2 production and CO_2 reduction. The nano-sized metal with localized surface plasmon resonance should be effective for various green chemical catalysis. The transparent nanoporous thin film with single-site photocatalyst generates the superhydrophilic and/or superhydrophobic surface with self-cleaning effect. The utilization of single-site photocatalysts is promising methodology applied in various fields to design unique functional materials.

【Publications Relevant to the Project】

・K. Fuku, K. Mori, H. Yamashita, et al., "The Synthesis of Silver Nanoparticles by Using Microwave Heating and their Enhanced Catalytic Activity by LSPR", *Angew. Chem. Int. Ed.*, 52, 7446-7450 (2013).
・Y. Kuwahara, H. Yamashita, C. Jones, et al., "Dramatic Enhancement of CO_2 Uptake by Poly(ethyleneimine) Using Zirconosilicate", *J. Am. Chem. Soc.*, 134, 10757-10760 (2012).

【Term of Project】 FY2014-2018

【Budget Allocation】 110,500 Thousand Yen

【Homepage Address and Other Contact Information】

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