

【Grant-in-Aid for Specially Promoted Research】 Science and Engineering (Engineering)



Title of Project : Development of innovative water splitting photocatalysts based on photocarrier dynamics at solid/liquid interfaces

Kazunari Domen
(The University of Tokyo, Graduate School of Engineering,
Professor)

Research Area : Catalyst/Resource chemical process, Functional materials

Keyword : Catalysis reaction, Photocatalyst, Surface/Interface

【Purpose and Background of the Research】

Hydrogen is the most convenient product from solar technology because it has a very high chemical energy, it can be used efficiently in fuel cells, and produces little pollution. We have developed the most highly active photocatalyst for overall water splitting under visible light irradiation in the world, which achieved a quantum yield of 5% at a wavelength of 410 nm. To achieve efficient one-step water splitting, an effective means of separation of photoexcited carriers and elucidation of the chemistry of energy conversion systems is required.

This project is aimed at the development of a photocatalytic system for one of the artificial photosynthesis systems for water splitting, to convert solar energy into chemical energy with unprecedented high efficiency. To address this objective, the precise analysis of the dynamics of photoexcited carriers and the surface reaction mechanisms will be performed. The goal of this project is the development of an innovative method to obtain practical photocatalysts for solar hydrogen production from water, on the basis of fundamental principles.

Structure design

development of photocatalyst
design of cocatalyst
band control at interfaces

Structure design in μm to nm scale
Thin film techniques

Realization of highly efficient
photocatalytic water splitting
under visible light irradiation

Spectroscopy / Microscopy
Elucidation of Mechanism

carrier migration / lifetime
potential barrier at interfaces
chemical reactions at interfaces

Observation

【Research Methods】

Topics in this project are as follows:

- (1) improvement of the synthesis method of photocatalyst for shape and size control
- (2) development of surface modifications
- (3) *in-situ* analysis for nano-structures by spectroscopy and microscopy
- (4) evaluation of carrier dynamics under irradiation by time-resolved spectroscopy

【Expected Research Achievements and Scientific Significance】

This project explores fundamental aspects of photocatalytic reactions focusing on photoexcited carrier dynamics, and covers the fields from solid state physics to surface chemistry. The development of water-splitting photocatalysts driven by solar radiation is likely to have a major impact both on basic science and society.

【Publications Relevant to the Project】

- 1) K. Maeda, T. Takata, M. Hara, N. Saito, Y. Inoue, H. Kobayashi, K. Domen, "GaN:ZnO Solid Solution as a Photocatalyst for Visible-Light-Driven Overall Water Splitting", *J. Am. Chem. Soc.*, **127**, 8286-8287, (2005).
- 2) K. Maeda, K. Teramura, D. Lu, T. Takata, N. Saito, Y. Inoue, K. Domen, "Photocatalyst releasing hydrogen from water - Enhancing catalytic performance holds promise for hydrogen production by water splitting in sunlight", *Nature*, **440**, 295, (2006).

【Term of Project】 FY2011-2015

【Budget Allocation】 410, 600 Thousand Yen

【Homepage Address and Other Contact Information】

<http://www.domen.t.u-tokyo.ac.jp/>

Fig. 1 Outline of this project