PHOTOCATALYTIC WATER SPLITTING TO GENERATE CLEAN AND RECYCLABLE HYDROGEN

Akihiko KUDO
Department of Applied Chemistry, Tokyo University of Science, Tokyo, Japan
e-mail:a-kudo@rs.kagu.tus.ac.jp

Energy and environmental issues in a global level are important topics. It is indispensable to construct clean energy systems in order to solve the issues. Hydrogen will play an important role in the system because it is an ultimate clean energy. It can be used for a fuel cell. Moreover, hydrogen is used in chemical industries. At present, hydrogen is mainly produced from fossil fuels such as a natural gas by steam reforming. In this process, fossil fuels are consumed and CO_2 is emitted. Hydrogen has to be produced from water using natural energies such as sunlight if one thinks energy and environmental issues. Therefore, achievement of the solar hydrogen production from water has been urged. Photocatalytic water splitting is one of the methods for solar hydrogen production from water in the future. Sunlight shines at photocatalyst powders dispersed in a pool with water, and then hydrogen is readily obtained. So, photocatalytic water splitting is an attractive reaction and will contribute to an ultimate green sustainable chemistry and solving energy and environmental issues resulting in bringing an energy revolution. New photocatalyst materials for water splitting have recently been discovered one after another. For example, a highly efficient water splitting was achieved using a powdered photocatalyst of $NiO/NaTaO_3$:La under UV irradiation. The finding has proven that highly efficient water splitting is actually possible using powered photocatalysts. New powdered photocatalyst systems of oxynitrides such as $Cr_xRh_{2-x}O_3$/GaN:ZnO and Z scheme such as $Ru/SrTiO_3$:Rh-$BiVO_4$ have been developed for overall water splitting under visible light irradiation. Solar water splitting is confirmed using the $Ru/SrTiO_3$:Rh-$BiVO_4$ photocatalyst system. Moreover, in the presence of sulfur compounds of electron donors, the sulfide solid solution photocatalysts $AgInS_2$-$CuInS_2$-ZnS are highly active for H_2 evolution under solar light irradiation. H_2 is realistically obtained under sunlight irradiation. Thus, the library of photocatalyst materials becomes plentiful. Although the photon energy conversion using powdered photocatalysts is not at the stage of practical use, the research in photocatalytic water splitting is being advanced. The photocatalytic water splitting is still a challenging reaction even if the research history is long. In the present paper, heterogeneous photocatalyst materials for water splitting are introduced.