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Construction of a solid-state overall water-splitting photocatalyst, sensitive to red-light for solar hydrogen production

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Various photocatalytic materials aiming at water-splitting have been enthusiastically investigated because produced hydrogen (H_2) is attractive as a clean and renewable fuel. To date, one of the candidate methods to split water to H_2 and oxygen (O_2) at a ratio of 2:1 under visible light is a combined system of half reaction photocatalysts, that is, H_2-evolution and O_2-evolution photocatalysts. However, because such the combination system, which is termed Z-scheme, requires a suitable redox couple, the system is not in fact able to split pure water. For the practical application, splitting pure water with no added chemicals is presumed to be favorable. Recently, we reported an Ag-inserted solid-state hetero-junction photocatalyst for water-splitting under visible light, like a Z-scheme system but is not required for a redox mediator. So, this system is capable of splitting pure water. In this system, Ag acts as a solid electron mediator for water-splitting. We selected $ZnRh_2O_4$ (band-gap (E.g. 1.2 eV) and $AgSbO_3$ (E.g. 2.5 eV) as H_2- and O_2-evolution photocatalysts, respectively. The system was able to respond to visible light up to 545 nm depending on the photo-absorption capability of $AgSbO_3$ (in fact, defective $AgSbO_3$). So, we replaced $AgSbO_3$ with $Bi_4V_2O_{11}$ (E.g. 1.7 eV) as the O_2-photocatalyst. Utilizing thus constructed Ag-inserted $ZnRh_2O_4$ and $Bi_4V_2O_{11}$ photocatalyst, the simultaneous liberation of H_2 and O_2 from pure water at a stoichiometric ratio was achieved under irradiation with visible light up to wavelengths of 740 nm. In place of Ag, Au-inserted $ZnRh_2O_4$ and $Bi_4V_2O_{11}$ photocatalyst was also able to accomplish overall pure-water-splitting under visible light up to 740 nm with improved activity.

Biography

Hiroshi Irie has pursued his BE and ME degrees in Inorganic Materials Science from Tokyo Institute of Technology in 1992 and 1994, respectively. He had worked at Sumitomo Metal Industries, Ltd. as a Research Engineer. He had received his PhD degree from the University of Tokyo in the Department of Interdisciplinary Studies. He was a Research Staff Member at Kanagawa Academy of Science and Technology until 2001. He later joined the University of Tokyo as a Research Associate and became a Lecturer and an Associate Professor at the University of Tokyo in 2006 and 2008, respectively and then he was promoted to a Full Professor at Clean Energy Research Center in University of Yamanashi. His current research interests include creations of high-performance energy-conversion materials such as photocatalysts, thermoelectric materials and so on.

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