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Overall solar water splitting reactor and plant design towards mass production of H_2 and O_2

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This paper overviews our ongoing research and development in designing the sunlight-driven self-running plant for H_2+O_2 generation from water as the technical goal of our all-Japan research project "Japan Technological Research Association of Artificial Photosynthetic Chemical Process" (ARPChem). Among various principles and real materials for photocatalytic water splitting, we herein focus on the type of powder photocatalyst from a single light-absorbing material. In this case, H_2 evolution from H^+ and O_2 evolution from OH- in water simultaneously run on a light-responding solid particle generating carriers therein, by the aid of "co-catalytic" materials dressing the surface. For our benchmark pilot plant, we use $SrTiO_3$, the most developed and successful powder photocatalyst. The original study of stoichiometric $2H_2$+O_2 evolution by ultraviolet light was performed on $SrTiO_3$. Later, Al-doped $SrTiO_3$ was introduced as an UV-active stoichiometric water splitting single-powder photocatalyst that realizes a quantum efficiency of 69% at 320 nm by the aid of CrOx+Rh cocatalyst. Because of the small fraction of UV light within the sunlight, the solar-to-H_2 energetic conversion efficiency is approximately 0.6 %. Nevertheless this simplicity of water photo-splitting mechanism is a preferable feature in designing solar plants. In this talk we will further discuss on the design for the photoreactor containing the photocatalyst, inhaling water and exhaling the product gas mixture. The following processes for safe transportation of explosive $2H_2$+O_2 mixture and operation of H_2/O_2 separation membrane will be also generalized.

Biography

Taro Yamada earned his Ph.D. degree at the University of Tokyo in 1984 and since then he occupied professional research scientist's positions at the Institute for Solid State Physics/the University of Tokyo, ERATO/JST, Waseda University, RIKEN institute and now is a leading member of Japan Technological Research Association of Artificial Photosynthetic Chemical Process (ARPChem) at the University of Tokyo. He has published more than 130 scholarly articles in the basic fields of surface science, catalysis, electrochemistry, and photocatalysis.

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