Decoupled Water Electrolysis Toward Selective Generation of Hydrogen and Oxygen

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Hydrogen has potential to develop a cleaner and more sustainable world. It is used as transportation fuels, chemicals in industry, or heating source. There are several techniques to produce hydrogen such as water electrolysis, steam reforming, or biomass from trees or agricultural crops[1]. Of these methods, water electrolysis has some advantages. It can be conducted at moderate conditions and the reactions can be easily controlled by adjusting the applied potential or current. However, in the conventional water electrolysis system, both hydrogen and oxygen generate at the same time, and this causes some problems[2]. High operating pressures and the pressure difference between hydrogen and oxygen require high durable separators. There is also safety issue caused from gas mixing because of the co-generation of hydrogen and oxygen at the same time and place. If water electrolysis is decoupled, and hydrogen and oxygen evolution are separated, these kinds of problems will be solved. An operational flexibility will be improved as well. Our aim of this work is to produce hydrogen and oxygen separately by using redox species as a mediator. In this work, iodide and iodate ion couples were used to investigate the decoupled water electrolysis which proceeds in two reaction steps. To find in which potential the redox reaction happens and in which potential hydrogen or oxygen starts to generate, relationships between applied potential and current were measured. At the determined potential by forementioned technique, electrolysis was conducted by using a two-compartment cell. At the first reaction step, only hydrogen generated and at the other side of the cell conversions from iodide ions to iodate ions proceeded with the maximum Faraday efficiency of 98%. At the second reaction step, only oxygen generated from one side and conversions from iodate ions to iodide ions proceeded with the maximum Faraday efficiency of 100% at the other side. Therefore, both hydrogen and oxygen were separately and efficiently produced by using iodine redox species.

References

[1] N. Armaroli, V. Balzani, *ChemSusChem*, 4 (2011) 21-36.
[2] B. You, Y. Sun, *Acc. Chem. Res.*, 51 (2018) 1571-1580.

Figure

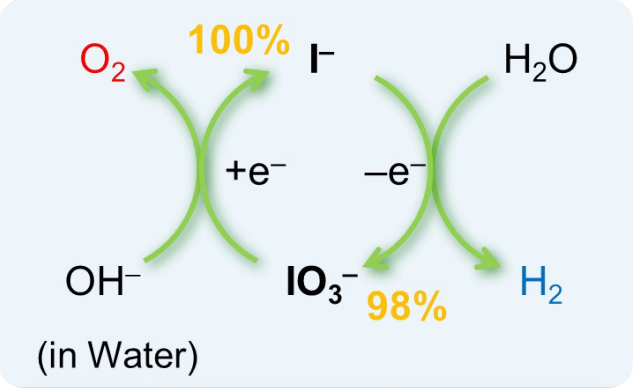

Figure 1: Outline of decoupled water electrolysis system using iodine redox species.