Towards practical solar-energy conversion: *Photoelectrochemical cell and its applications*

by

Dowon Bae

Materials for Energy Conversion and Storage, Delft University of Technology, Netherlands
d.bae@tudelft.nl

Abstract

Over 36 billion tonnes of CO_2 has been emitted in 2015 [1]. In the Netherlands, merely around 4% of total energy production is derived from CO_2-neutral energy sources [2]. In this context, direct storing solar energy in hydrogen *via* photoelectrochemical (PEC) water splitting has been regarded as attractive. It has been shown that combination of photovoltaic materials, such as Si and III-V semiconductors [3, 4], with appropriate protection layer and co-catalyst, is an effective approach for the conversion efficiency. However, sluggish reaction kinetics and low stability of photoelectrodes greatly hamper its wide implementation [5]. Alternatively, PEC flow battery has been investigated as a mean of simultaneously storing the solar energy into chemicals, which can readily generate electricity *via* reversible reactions. Owing to its simple reaction pathway (generally, one electron reaction), the flow battery system present facile electrochemical kinetics and its energy storage capacity is several times longer than that of conventional battery systems [6]. Nonetheless, there are several challenges to be overcome for commercialization of the PEC flow battery system, such as low solar-to-chemical conversion efficiency and electrolyte degradation issues. During the presentation, the development trends in the PEC device for the water splitting and the flow battery field will be highlighted [3, 7]. Also, design proposal to realize a practical PEC flow battery system will be discussed as well.

[1] J. G. Olivier, J.-M. Greet, M. Muntean *et. al.*, *Trends in global CO_2 emissions: 2016 report*, Hague, 2016

[2] OECD, *OECD Environmental Performance Reviews: The Netherlands 2015*, OECD Publishing, 2015.

[3] D. Bae, T. Pedersen, B. Seger, M. Malizia, A. Kuznetsov *et. al.*, *Energy Environ. Sci.*, 2015, **8**, 650-660.

[4] W.-H. Cheng, M. H. Richter, M. M. May, J. Ohlmann, D. Lackner *et. al.*, *arXiv:1706.01493*.

[5] D. Bae, B. Seger, P. C. K. Vesborg, O. Hansen and I. Chorkendorff, *Chem. Soc. Rev.*, 2017, 46, 1933-1954.

[6] W. Wang, Q. Luo, B. Li, X. Wei, L. Li and Z. Yang, *Adv. Funct. Mater.*, 2013, **23**, 970-986.

[7] K. Wedege, D. Bae, W.A. Smith, A. Mendes, A. Bentien, *J. Phys. Chem. C*, 2018 (Submitted)

Biography

Dowon Bae received his BSc and MSc (Honors, 2006 and 2008) from the Russian State Technological University named after K.E. Tsiolkovsky. After research activities within solar cells at the LG Innotek (South Korea; 2008 – 2012), he joined the ‘‘CINF’’ (Center for Individual Nanoparticle Functionality) at the Technical University of Denmark (DTU), where he conducted his PhD study and Postdoc under the supervision of Prof. Ib Chorkendorff. Presently, he is a Postdoc at the Prof. Wilson Smith’s lab, Department of Chemical Engineering, the Delft University of Technology with LEaDing Fellowship (Marie-Curie COFUND) support. His research concerns PEC device design and its application for the flow-battery system.