Photoelectrochemical Water Splitting for Eco-friendly Hydrogen Generation

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Solar energy is the largest renewable energy source to meet the increasing global demand for energy. However, it requires the efficient storage method because it is intermittent and only active during the daytime. Photoelectrochemical (PEC) water splitting has been considered as one of promising candidates for storing solar energy into chemical energy in the form of hydrogen. A PEC water splitting photocathode for generating hydrogen is based on a p-type semiconductor and liquid junction. Cuprous oxide (Cu_2O) is an attractive p-type semiconductor material for PEC water splitting photocathode since it is abundant, cheap and eco-friendly. Moreover, it has a band gap of 2.0 eV with the suitable energy band position for PEC hydrogen production[1-3]. However, it still has two main challenges for the feasible PEC water splitting: low performance and poor stability in the aqueous solution.

In this presentation, the efforts on solving these challenges will be discussed. In terms of the first issue, the structural modification of Cu_2O photocathodes has been introduced to improve the PEC performance. Nanostructured Cu_2O photocathodes provide not only efficient charge transport pathway but also improved light utilization by the light trapping effect[4]. In addition, the additional layers including n-type semiconductor overlayers such as AZO and Ga_2O_3 and hole selective underlayer such as CuO/NiO mixed thin film[5] are efficient to accelerate the charge separation and to prevent the charge recombination in Cu_2O photocathodes. On the other hand, the intrinsic stable oxide layers such as TiO_2 and SnO_2 have been adopted as the protection layer[6,7], in terms of the improved stability. Finally, the feasibility of new materials such as copper based ternary oxide and lanthanum iron oxide will be discussed toward on the efficient and durable PEC water splitting.

[1] A. Paracchino, et. al., J. Phys. Chem. C 116 (2012) 7341.
[2] A. Paracchino, et al., Nat. Mater. 10 (2011) 456.
[3] R. Wick, et al., J. Phys. Chem. C 119 (2015) 26243.
[4] J. Luo, et al., Nano Lett. 16 (2016) 1848.
[5] M.-K. Son, et al., Energy Environ. Sci. 10 (2017) 912.
[6] A. Paracchino, et. al., Energy Environ. Sci. 5 (2012) 8673.
[7] J. Azevedo, et al., Nano Energy 24 (2016) 10.