Photoelectrochemical characterization of ternary oxide film for solar-driven water splitting: sputtered $LaFeO_3$ and electrodeposited $CuFeO_2$

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Photoelectrochemical (PEC) water splitting has been considered as a simple and sustainable hydrogen production pathway because we only need semiconductor electrode, water and solar energy to generate hydrogen. In general, p-type semiconductors are adopted to implement photocathode, which is a part to generate hydrogen, because minority carriers in the p-type semiconductor easily move to the water interface. It is well-known that cuprous oxide (Cu_2O) is the most promising p-type semiconductor. Recently, the significant improved PEC performance has been achieved by Cu_2O photocathodes with nanowire structures and gallium oxide overlayers. However, the challenge of Cu_2O photocathode is its poor stability in the water. Ternary oxide materials are one of solutions to overcome this problem because they are more resistant to the corrosion in the aqueous solution than binary ones.

In this talk, two ternary oxide materials are introduced: one is lanthanum iron oxide ($LaFeO_3$) and the other is copper iron oxide ($CuFeO_2$). The former is a perovskite semiconductor with a band gap of 2.1~2.4 eV, while the latter is a delafossite semiconductor with a band gap of 1.6 eV. Therefore, they can utilize the visible light of sunlight. In addition, they have suitable band position for water reduction reaction. The $LaFeO_3$ film is fabricated by the plasma sputtering deposition, which is simple, low cost and able to yield the uniform stoichiometric film. The crystalline $LaFeO_3$ film is completed by the post annealing process at the temperature above 550 ^oC. On the other hand, the $CuFeO_2$ film is fabricated by the electrodeposition, which is an industrially proven and low cost method. It is controlled by the solvent of electrodeposition solution, applied current density and deposition time. The crystalline $CuFeO_2$ film is completed by the post annealing process at 650 ^oC in the nitrogen atmosphere. Finally, the PEC characterization of these two films is carried out to confirm the application to the PEC water splitting.

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