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論　文　内　容　要　旨

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学位論文題目	Preparation and Characterization of CuO_x-based Photocatalyst and NiFeP-based Electrocatalyst for Water Splitting （水分解用CuO_x光触媒とNiFeP電極触媒の製作と特性評価）		

内容要旨

Water splitting for hydrogen evolution is a potential technique to solve the crises of energy shortage and environment pollution. In recent years, this research area has achieved a great progress by the persistent efforts of the researchers.

In this thesis, we reported on two kinds of methods for overall water splitting, include photoelectrochemical water splitting and electrocatalytic water splitting. Solar energy conversion through photoelectrochemical water splitting by semiconductors has becoming one of the most effective ways to solve energy and environmental issues. Electrocatalytic water splitting can be regarded as a promising one for clean energy and renewable. Synthesis of stable and efficient electrocatalysts is paramount importance for hydrogen evolution reaction, and oxygen evolution reaction.

Firstly, the CuO_x composite photocatalyst were deposited on FTO transparent conducting glasses by alternating current magnetron reactive sputtering under different Ar/O_2 ratios. The advantage of this deposited method is that it can deposit a CuO_x photocatalyst uniformly and rapidly with large scale. From the photoelectrochemical properties of these CuO_x photocatalysts, it can be found that the CuO_x photocatalyst with Ar/O_2 30:7 provide a photocurrent density of -3.2 mA/cm^2 under a bias potential -0.5 V (vs. Ag/AgCl), which was found to be twice higher than that of Ar/O_2 with 30:5. A detailed characterization on the structure, morphology and electrochemical properties of these CuO_x photocatalysts were carried out, and it is found that the improved PEC performance of CuO_x photocatalyst with Ar/O_2 30:7 attributed to the less defects in it, indicating that this Ar/O_2 30:7 is an optimized condition for excellent CuO_x photocatalyst fabrication.

Secondly, a CuO_x/WO_3 photocatalyst based on p-n heterojunction proposed as a highly performance and stable photocathode. The CuO_x/WO_3 photocatalyst was deposited by magnetron reactive sputtering layer by layer, followed with slow rate annealing in O_2 ambient. This is an excellent method for high-quality and uniform composite thin-film deposition with large areas at a high growth rate. The optimized CuO_x/WO_3 photocatalyst after slow rate annealing at 500 °C in O_2 provides an obviously enhanced photoinduced current density of -3.8 mA cm^{-2} at a bias potential of -0.5 V (vs. Ag/AgCl), which value is 1.5 times higher than that of bared CuO_x. This highly enhanced photoelectrochemical performance is

attributed to p-n heterojunction, which accelerates the photogenerated electrons and holes transfer to n-WO_3 and p-CuO_x, thereby accelerate the separation of photogenerated carries. In addition, WO_3 layer covered on the surface of CuO_x photocatalyst can improve the stability of Cu_2O in electrolytes.

Lastly, a new highly active and cost-effective nanocomposite electrocatalyst Ni-Fe-P-$FeMnO_3$ supported on nickel foam has been designed and prepared by electroless composite deposition and rapid dealloying. The nanocomposite electrocatalyst Ni-Fe-P-$FeMnO_3$/NF presents a remarkable electrocatalytic activity towards HER, which demands a quite low overpotential of 16.62 mV at -10 mA cm^{-2} current density in 1 M KOH, which behaves better performance than Pt/C noble metal catalysts. Moreover, Ni-Fe-P-$FeMnO_3$/NF electrocatalyst exhibits remarkable OER activity as well, which requires only 297 mV and 219 mV of overpotential at 50 mA cm^{-2} and 10 mA cm^{-2}, respectively. Evidently, its overall water splitting activity used as both anode and cathode performs a low overpotential of 1.63 V to reach 10 mA cm^{-2}. The high performances of the obtained electrocatalyst are mainly due to the unique structure of nano perovskite $FeMnO_3$ as well as the synergistic effect between nickel/iron and phosphorus.