Omi-directional Engineered $ZnFe_2O_4$ Photoanode for Solar Water Splitting

Ju Hun Kim[1]
Jae Sung Lee*[1]
[1]*School of Energy and Chemical Engineering, UNIST, Ulsan, Korea*

*E-mail: jslee1234@unist.ac.kr

Spinel ferrite could be a class of promising candidate photoanode because most of them has small band gap energies allowing large fraction of solar spectrum (1.6~2.1eV), suitable band edge energies for either oxidation water and/or reduction of protons, chemically and thermally stable and earth abundancy. In spite of the substantial potential, there have been a few studies on these materials mainly as a light absorber based on transparent conducting substrate because it is difficult to fabricate them on heat sensitive transparent conductive substrate (TCO) which require high temperature above 1000°C.

In here, commonly used hydrothermal and solution casting method for $ZnFe_2O_4$ synthesis on the FTO substrate was used and the omi-directional strategies were applied to improve the efficiency and it is demonstrated their contributions: (1) *Nanostruring* by all solution method for improving charge carrier transfer. (2) *Hybrid microwave annealing* contributing to preserve nanostructure and to maintain FTO conductivity without aggregation and degradation of its performance. (3) *Insertion of underlayer* inducing extrinsic doping due to self-diffusion from underlayer and blocking back electron injection. (4) *Hydrogen treatment* occurring intrinsic doping due to oxygen vacancies and passivating surface states. (5) *Co-catalyst loading* enhancing the kinetics of hole transfer at photocatalytic active surface.

Through those engineering, the PEC water oxidation activity remarkably increased around 37 times relatives to the as-prepared $ZnFe_2O_4$ electrode. The various characterization and hole scavenger experiment with H_2O_2 reveal that this omi-directional engineered $ZnFe_2O_4$ enhanced bulk charge separation efficiency from 2 to 30 % as well as surface charge separation efficiency from 40 to 80%.

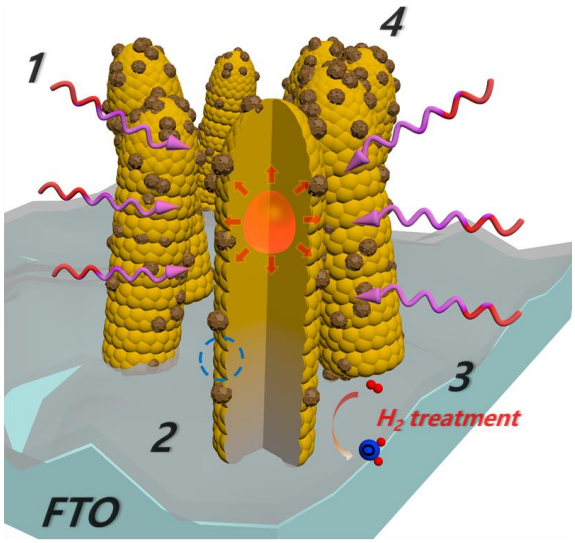

Fig.1 Illustration of omi-directional strategies on $ZnFe_2O_4$ Photoanode

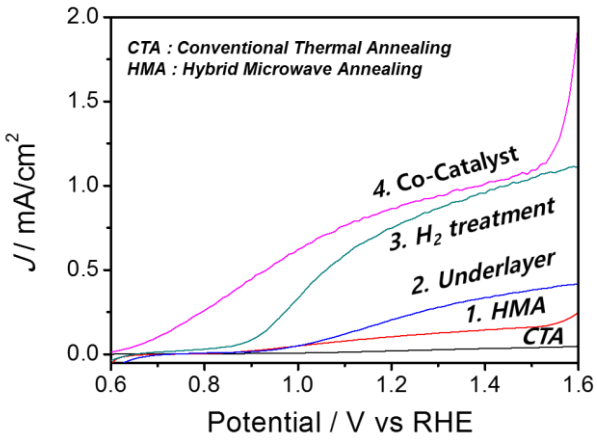

Fig. 2 J-V curves of omi-directional engineered $ZnFe_2O_4$ photoanode under 1 sun condition.

REFERENCES

[1] Kim. J.H., Kim. J. H., Jang. J.W., Choi. S.H., Magesh. G., Lee. J. and Lee. J. S., Adv. Energy. Mat., 5(6), 2015

[2] Kim. J.H., Jang. Y.J., Kim. J. H., Jang. J.W., Choi. S.H. and Lee. J. S., Nanoscale, 7(45), 2015, 19144.

[3] Kim. J. Y., Youn. D. H., Kim. J.H., Kim. H.G. and Lee. J. S., ACS Appl. Mater. Interfaces., 7(25), 2015, 14123

[4] Kim. J. H., Jo. Y. H., Kim. J. H. and Lee. J. S., 8(40), 2016, 17623