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Professor Sanghan Lee's research team produces high efficiency hydrogen electrodes for nanorods and plasmonic nanoparticles

☐ Korean researchers have confirmed that it is possible to increase the production efficiency of environmentally friendly hydrogen energy by designing and fabricating new biodegradable photoelectrodes with plasmonic * metal nanoparticles dispersed on the surface.

* Plasmonic effect: the effect of free electrons in the metal collectively oscillating in a similar particle effect

☐ GIST (President Seung Hyeon Moon) − Professor Sanghan Lee of the School of Materials Science and Engineering is leading a research team that is investigating a new type of plasmonic zinc oxide * nanostructure with gold nanoparticles dispersed on the surface of bismuth-vanadate * and has developed a photo-electrode *** for hydrogen hydrolysis.

* Zinc oxide (ZnO): a material with a band gap of 3.2 eV that helps charge transfer and absorption of the ultraviolet region

** Bismuth-vanadate (BiVO4): an n-type semiconductor material with a relatively low band gap of 2.4 eV

*** Photo-electrode: an electrode made of materials that absorbs sunlight to generate electrons and ions

☐ In order to produce eco-friendly hydrogen energy efficiently, the photo-electrode should absorb as much light as possible and generate a large amount of electrons (basic particles that have a negative charge) and ions (basic particles that have a positive charge). In addition, it is more important to increase the probability that the generated electrons and ions will react with each other in a rapid manner without them recombining.

☐ The researchers used a new type of multi-structured photo-electrode, in which the bismuth-vanadate, the most popular photo-electrode material, was thinly coated on a zinc oxide nanowire to form a heterogeneous structure, and gold nanoparticles were dispersed thereon. Researchers predicted that both absorption and charge transfer can be improved. As a result of the fabrication and measurement of the multi-structure photo-electrode, it was confirmed that the light absorption and charge transfer characteristics were improved compared to the conventional bismuth-vanadate photo-electrode, and the photocurrent density * value was greatly increased.

* Photocurrent density: the value obtained by dividing the current generated by the charge separation phenomenon by the light receiving area when irradiating the light electrode

- In other words, the zinc oxide in the nanowire form has a structural advantage to scatter light to improve absorption, to prevent recombination of generated charges, and to facilitate rapid charge transfer. In addition, within the gold nanoparticles, the molecules oscillate collectively to improve the absorption of light, creating a strong electric field on the surface and making the reactivity at the photo-electrode and water interface active.

- The improvement of photocurrent density of the photo-electrode caused by these effects is directly related to the improvement of the efficiency of converting solar energy to environmentally friendly hydrogen energy. Therefore, the production of multiple photo-electrodes incorporating nanorods and plasmonic nanoparticles into a photoactive material can result in increased hydrogen production efficiency.

☐ Professor Sanghan Lee said, "We have clearly confirmed that the photo-electrode, which is made by dispersing the plasmonic gold nanoparticles in a heterogeneous structure with a thin coating of bismuth vanadate on a zinc oxide nanorod, can be used for light absorption as well as charge transfer. It is the greatest achievement of this study to confirm that the fabrication and utilization of various photoactive material-based photo-electrodes using nanorods and plasmonic nanoparticles can be a very effective way to improve hydrogen production efficiency."

☐ This research led by Professor Sanghan Lee of the School of Materials Science and Engineering was published in *Catalysis Science & Technology* (IF=5.365) on May 23, 2018, and was selected as its back cover in recognition of its importance.

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