Gwangju Institute of Science and Technology

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Professor Sanghan Lee's research team produces high efficiency eco-friendly hydrogen by controlling the direction of photoelectrode crystals

□ GIST (President Seung Hyeon Moon) – Korean researchers led by Professor Sanghan Lee of the School of Materials Science and Engineering confirmed the possibility of significantly improving the production efficiency of environmentally friendly hydrogen energy by controlling the crystal orientation of the photoelectrode. The researchers' experiment demonstrated that bismuth vanadate * photoelectrode ** has different photoreaction characteristics depending on the direction of the crystal ***. Thus, it is necessary to control the grain orientation of the photoelectrode for more efficiency.

*Bismuth vanadate ($BiVO_4$): an n-type semiconductor material with a relatively low band gap of 2.4 eV

** Photoelectrode: an electrode made of material that absorbs sunlight to generate electrons

*** Crystal: a solid state material in which atoms and ions are regularly arranged

□ A photoelectrode is an electrode made of a material that absorbs sunlight to generate electrons that react with water to generate environmentally friendly hydrogen energy. Therefore, in order to produce eco-friendly hydrogen energy efficiently, it is important to

increase the probability that the generated charges are transferred to the interface with water, increasing the probability that they will react.

□ The researchers first experimentally demonstrated that bismuth vanadate, the most popular photo-electrode material, has different charge transport properties depending on the direction of the crystal. The study confirmed that the photocurrent density * values depend on the charge transfer characteristics of the bismuth vanadate photoelectrode thin films were significantly different from each other in the crystal direction.

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

◦ The photocurrent density was improved by more than 300% in the horizontal crystal direction (b-axis, (010) direction) as compared with the vertical crystal direction (c-axis and (001) direction). The improvement of the photocurrent density is directly related to the improvement of the efficiency of converting solar energy into environmentally friendly hydrogen energy. Furthermore, the research team explained that the production of photoelectrodes in specific crystal directions can result in higher hydrogen production efficiency.

□ Professor Sanghan Lee said, "It is clear from this study that bismuth vanadate, a common photoelectrode material for environmentally friendly hydrogen production, has anisotropy in the charge transfer characteristics depending on the crystal orientation. This is a great achievement confirming that the fabrication of electrodes can be a very effective way to improve hydrogen production efficiency."

□ This research was led by Professor Sanghan Lee and sponsored by the Ministry of Science and Technology, Ministry of Information and Communication, the Korea Research Foundation, and the GIST Climate Change Response Technology Development Project. The findings were published on May 22, 2018, in *ACS Catalysis* (IF = 10.614), a worldwide international academic journal in the field of chemistry. ⌘