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Professor Sanghan Lee's research team develops multilayer catalyst for efficient hydrogen production

☐ GIST (President Kiseon Kim) – A research team led by Professor Sanghan Lee of the School of Materials Science and Engineering has developed a multilayer catalyst that uses solar energy to decompose water to maximize the efficiency of photo-electrodes used to produce hydrogen.

☐ Hydrogen is a clean fuel that makes no by-products other than water, and it is an eco-friendly resource to replace fossil fuels. Therefore, technologies that produce hydrogen environmentally friendly are receiving keen attention, and the most representative technology is photo-electric chemical water decomposition, which uses solar energy to decompose water and produce hydrogen.

◦ The material used for photo-electrochemical decomposition is silicon, which is used in solar cells. However, in the case of the silicon photo-electrode, the efficiency of transferring the generated electrons to water is very low. Therefore, it is necessary to use an expensive noble metal catalyst such as platinum.

- Professor Sanghan Lee's research team used the transition metal diahlcogenides (TMDs)*, which are expected to replace the precious metal catalyst. TMDs, a thin two-dimensional layered material similar to paper, have the advantage of transparency and superior catalytic properties, which significantly increases the efficiency of silicon photo-electrodes even in small amounts.

  * transition metal diahlcogenides: chemical substances made by combining transition metal cations and anions such as selenium and sulfur, which are elements of the chalcogens family

- In the past, studies on applying a single TMDs catalyst to silicon have been performed, but the researchers have developed a multi-layer TMDs* thin film with a stepped band structure by stacking different TMDs.

  * multi-layer TMDs thin film: consists of molybdenum sulphide (MoS2) / tungsten sulphide (WS2) / tungsten selenides (WSe2)

- The multi-layer TMDs catalysts developed by the researchers improved the flow of electrons compared to a single TMDs catalyst, resulting in increased photocurrents generated from light that are about 3 times to 20 times greater at the same voltage as a single TMDs catalyst.

- To create multi-layered TMDs, the research team used pulsed laser deposition* to deposit TMDs directly on silicon substrates. This eliminates the need for additional processes, such as the individual deposition and transfer processes used in typical TMDs processes, which simplifies existing complex processes.

  * pulsed Laser Deposition: vapor deposition of a target material with a high-energy pulse laser to deposit a thin film

□ Professor Sanghan Lee said, "We hope that this multi-layer TMDs thin film catalyst will contribute greatly to the production of environmentally friendly hydrogen in the future. Multi-layer TMDs synthesis method using pulsed laser deposition method will be applied

not only to eco-friendly catalysts in the future but also to various fields such as semiconductor devices and light emitting devices."

□The research was led by Professor Sanghan Lee (corresponding author) of the School of Materials Science and Engineering with Ph.D. student Sehun Seo as the first author and was supported by the Basic Science Research Program and Creative Materials Discovery Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education and the Ministry of Science and ICT and by the GIST Research Institute (GRI). The research was published on April 26, 2019, in *Advanced Science* (IF = 12.441), a well-known journal in the field of materials.

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