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Professors Sanghan Lee and Kwanghee Lee's discovers clue to improving hydrogen production efficiency using next-generation solar cells (National Research Foundation of Korea)

- A new attempt was introduced to stably obtain hydrogen without emission of carbon dioxide using perovskite solar cells, which is one of the candidates for next-generation solar cells.

  * perovskite: The name of the crystal structure (ABX3) of minerals discovered by Russian mineralogist Lev Perovski (17922-1856) in 1839. Among them, organic-inorganic mixed perovskite is widely used as a material for solar cells because it not only can absorb light in a wide range, but it also has high absorption.

- GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Materials Science and Engineering Professors Sanghan Lee and Kwanghee Lee's research team confirmed that effective and stable hydrogen production is possible with perovskite internal defect control and liquid metal sealing technology.

  - There have been previous studies to produce hydrogen with perovskite solar cells (water electrolysis and photoelectrochemical water decomposition), but perovskite's ionic defects and susceptibility to moisture were obstacles.

    * ion defect: a foreign material inside the crystal material with a charge

    * water electrolysis: a method of producing hydrogen molecules (H_2) and oxygen molecules (O_2) by electrolyzing water molecules (H_2O)

    * photoelectrochemical water splitting: a method of producing hydrogen and oxygen by breaking down water molecules with electricity generated from light

- The research team used L-proline, a type of amino acid, as an additive to compensate for ion defects in the perovskite itself.

    - L-proline, which can have both cations and anions under certain conditions, improves the efficiency and stability of the device by filling all of the cation defects and anion defects inside the perovskite.

        * L-proline: As one of the 20 amino acids that make up a protein, it has both amine and carboxyl functional groups, and the charge of the functional groups varies depending on the pH of the solution.

        * zwitterion: an ion that has a cation and an anion in one molecule at the same time

- Also, by sealing the perovskite with indium gallium liquid metal and titanium foil, the vulnerability to moisture was solved. Not only was it not affected by moisture, but it also increased the charge transfer between the electrode and the device, which further improved the hydrogen production efficiency.

    - The device made in this way has more than twice the stability of the conventional perovskite photoelectrochemical device, and the hydrogen production efficiency (half cell efficiency) is also 9.6%, which is the best performance among photoelectrochemical devices using perovskite materials. The research team plans to carry out research on perovskite materials for more stable hydrogen production and catalyst research to lower production costs.

- The results of this research, which were conducted with support from the Global Research Laboratory (GRL) Program of the National Research Foundation (NRF) and by the GIST Research Institute (GRI), were published online on

January 21, 2021, in *Advanced Functional Materials*, which is an international journal on materials.

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