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Section of Public Relations	Dongsun Cho Section Chief 062-715-2061	Nayeong Lee Senior Administrator 062-715-2062
Contact Person for this Article	Professor Kwanghee Lee School of Materials Science and Engineering 062-715-2325	
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Professor Kwanghee Lee and Professor Heejoo Kim's research team proposes a new method for improving the performance of perovskite solar cells

□ GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Materials Science Professor Kwanghee Lee and Engineering Institute of Integrated Technology Professor Heejoo Kim proposed a method to increase the efficiency of perovskite solar cells by utilizing ions in which positive and negative ions exist simultaneously in one molecule.

◦ The research team confirmed that the performance of perovskite solar cells can be improved through passivation* of internal defects** of organic-inorganic complex perovskite through zwitterion*** additives.

* passivation: absorbing harmful ions or preventing movement of ions

** defect: where the periodicity of the atomic arrangement is broken in the perovskite crystal consisting of periodic arrangement of atoms

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

□ Organic/inorganic complex perovskite solar cells that are capable of solution processing are attracting attention as next-generation solar cells due to their

thin, light, and highly efficient device performance of over 25%. However, there is a problem in that the performance of the device decreases due to defects in the organic/inorganic complex perovskite material itself, so defect control is essential to make high-performance perovskite solar cells.

- Defects inside perovskite materials have a charge, and this charge is largely divided into positive electric charge and negative electric charge. In order to control this, a method of passivating using a material having one charge or unshared electron pair is widely known, but the limitation was that only one type of charge could be passivated.

□ The research team focused on the representative amino acids of zwitterions in which cations and anions exist simultaneously in one molecule. Among them, L-alanine*, which is simple and similar to the precursor of the perovskite material, was used.

* L-alanine: As one of the 20 amino acids that make up a protein, the charge of the functional group varies depending on the pH of the solution.

- L-alanine was used as an additive to perovskite materials to passivate defects in the material and increase grains, and it was confirmed that the solar cell device efficiency increased from 18.3% to 20.3%.

- It was confirmed that the improvement in device efficiency was due to the inhibition of nonradiative recombination* of perovskite materials through photoluminescence spectroscopy and time-related single photon calculation techniques, and, in particular, the photoluminescence lifetime increased by more than 10 times. In addition, the reduction of internal defects was measured using the space-limited current, and it was confirmed that zwitterions inhibited ion migration inside the perovskite by measuring the conductivity at low temperatures.

* nonradiative recombination: When holes and electrons recombine in a semiconductor, the energy that electrons have is radiated as heat.

□ Professor Kwanghee Lee said, "The results of this research suggest a new principle that can solve the problem of defects inside materials that must be solved in

the development of organic-inorganic hybrid perovskite solar cells, which are drawing attention as next-generation solar cells, with a simple zwitterion molecule. This is expected to be applicable not only to the solar cell field, but also to various semiconductor devices (light-emitting diodes, transistors, optical sensors, etc.) using mixed organic and inorganic perovskites."

□ This research was led by GIST School of Materials Science Professor Kwanghee Lee and Engineering Institute of Integrated Technology Professor Heejoo Kim and conducted by Ph.D. student Ju-Hyeon Kim and Research Institute for Solar and Sustainable Energies Yong Ryun Kim as first-authors with support from the GIST Research Institute (GRI) and was published online on January 21, 2021, in *Small*, an international journal in the field of nanotechnology.

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