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Professors Sukwon Hong and Kwanghee Lee's research team develops new hole transporting layer material that increases the lifespan of perovskite solar cells

☐ GIST (President Seung Hyeon Moon) – Professor Sukwon Hong of the Department of Chemistry and Professor Kwanghee Lee of the School of Materials Science and Engineering have developed a new hole transport layer material that the lifespan for next generation perovskite solar cells *.

* Perovskite solar cells: solar cells using perovskite crystalline organic/inorganic composite ionic crystalline materials as photoactive layers.

☐ Perovskite solar cells are attracting attention with high energy conversion efficiency of more than 20%. However, due to the characteristics of perovskite materials, which are vulnerable to moisture and oxygen, high device performance is not maintained.

◦ To prolong the lifespan of solar cells, attempts have been made to improve the stability of the solar cells by protecting the perovskite layer by introducing a new hole transport layer material between the electrodes of the solar cells and the perovskite active layer. However, such hole transport layer materials generally have a low

charge mobility and thus have a problem in reducing the energy conversion efficiency of the solar cells. There is a way to add a doping additive to increase the charge mobility, but, unfortunately, the lifetime of the device is greatly reduced due to the doping additive.

□ The researchers developed a new semiconductor material with no doping additives and hydrophobic properties to extend the lifetime of perovskite solar cells. PEDOT:PSS *, which is widely used as a hole transport layer material while exhibiting a high solar cell energy conversion efficiency (16%) by introducing a hole transport layer that can be covered with a thin and defect-free perovskite layer, increases the lifespan by more than five time (more than 80% of initial device efficiency).

* PEDOT:PSS poly (3,4-ethylenedioxythiophene) polystyrene sulfonate: A typical conjugated polymer material widely used as an organic electronic material.

◦ In addition, it is important to prevent the movement of electrons and selectively move the pores as factors that directly affect the energy conversion efficiency of pherovskite solar cells. This is an essential role for the fixed-air transport layer and requires a new semiconductor material that can be directly compared. By introducing electron donating group and electron withdrawing group substituents into a new polymer containing a boron * compound, the team found that the highest occupied molecular orbital ** and the lowest unoccupied molecular orbital *** were selectively controlled. By using these characteristics, it is possible to increase the energy conversion efficiency and to identify the main factors affecting device efficiency.

* Boron: element whose atomic number is 5 in the periodic table

** The highest occupied molecular orbital: the molecular orbital in the region with the highest energy in the region where electrons can participate in the bond

*** The lowest unoccupied molecular orbital: the molecular orbital in which the electron is in the lowest energy region in the unbonded region

□ Professors Sukwon Hong and Kwanghee Lee said, "This research has developed a new polymer containing a boron compound that can easily introduce substituents having different electronic properties and use it as a hole transport layer. Through this new polymer, we have been able to identify the factors directly affecting the energy conversion efficiency of perovskite solar cells and to prolong the lifespan of the device."

□ This research was supported by the National Research Foundation of Korea's Global Laboratory Project and the GIST GRI Project. The results were recently published in *ACS Applied Materials & Interfaces* (IF: 8.097), a top-level scientific journal in the field of nanotechnology and energy materials.

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