Gwangju Institute of Science and Technology

Official Press Release (https://www.gist.ac.kr/)

Section of Public Affairs	Mi-Yeon Kim Section Chief (+82) 62-715-2020	Nayeong Lee Senior Administrator (+82) 62-715-2024
Contact Person for this Article	Dr. Hee Chul Woo Apri Advanced Photonics Research Institute (+82) 62-715-3347	
Release Date	2018.08.07	

Dr. Chang-Lyoul Lee and Professor Jae-Suk Lee's joint research team has developed a high-efficiency, high-conductivity perovskite quantum dots through ligand diffusion modification

☐ GIST (President Seung Hyeon Moon) − Dr. Chang-Lyoul Lee and Professor Jae-Suk Lee of the Advanced Photonics Research Institute (APRI, Director Hyyong Suk) have have successfully developed high-quality perovskite quantum dots * for light-emitting diodes (LED) and developed quantum dot thin films.

* Quantum dot: nanometer (nm = billionths of a meter) size semiconductor crystals made by chemical synthesis process

☐ Quantum dot materials are attracting attention as a next-generation semiconductor material that can replace organic light emitting diodes (OLEDs), which are widely used in the TV and mobile markets due to their high luminous efficiency and color purity. However, to utilize existing quantum dot material (InP, ZnS, etc.) as an electroluminescent material, it is difficult to cover the material constituting the nucleus of the quantum dot with another shell material.

- Perovskite quantum dots are expected to be used as a key material in the future development of high-efficiency quantum dot light-emitting diodes because it has high luminescence efficiency and color purity without a shell structure.

☐ However, the perovskite material is a crystal made of ionic bonds of ions, such as salt crystals (NaCl), formed by ionic bonding, so it is difficult to utilize the existing quantum dot process. Conventional quantum dot processes use polar solvents such as water (H2O) because crystals made of ionic bonds easily decompose in polar solvents.

- In addition, the existing quantum dot materials are used by treating the surface with organic ligands (surfactants) to improve the stability of the materials and to disperse them in polar solvents. Depending on the physical properties of the surface organic ligands used, the characteristics of the quantum dot used in quantum dot light emitting diodes are also affected. However, the surface ligand treatment process never been developed for perovskite quantum dots, which is an obstacle to the optimization and device application of the perovskite quantum dot material.

☐ The researchers have developed a new perovskite quantum dot synthesis method that can control the electro emissivity and polarity density of solvents to ensure high crystallinity and luminous efficiency. The team also developed a new quantum dot surface ligand treatment process called the ligand diffusion modification method *, in which the organic ligand repeatedly bonds and dissociates between the surface and the solution of the quantum dots modifying the surface of the perovskite quantum dots.

* Ligand Diffusion Modification: A surface modifying method that removes defects on the surface of quantum dots and attaches ligands with various functional groups by using a phenomenon where the organic ligand as a surfactant repeatedly bonds and dissociates between the surface of the quantum dots and the solution.

- Perovskite quantum dot thin films with a PLQY of greater than 80% were fabricated using surface modified perovskite quantum dots. The researchers have developed perovskite electroluminescent diodes (LEDs) with 2.5 times more efficiency than those using a photoactive layer.

☐ Dr. Chang-Lyoul Lee said, "In addition to securing high photoluminescence efficiency by eliminating the internal and surface defects of the perovskite quantum dots, we have developed a ligand diffusion modifying method capable of attaching a ligand having various functional groups to the surface thereof, thereby making it possible to commercialize the perovskite quantum dot material."

☐ Professor Jae-Suk Lee said, "In this research, we have secured the technology for removing crystal and surface defect of multi-dimensional perovskite material which can be used as photoactive layer and luminescent layer in solar cell and electroluminescent devices."

☐ This research was supported by the National Research Foundation of Korea and the GIST Development Project and was the results were published on July 28, 2018, in *Nanoscale*.

⌘