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APRI Researcher Dr. Chang-Lyoul Lee's research team identifies the principle of room temperature luminescence of perovskite quantum dots

☐ A GIST research team has identified the principle of room temperature luminescence of perovskite * quantum dots, which can be used as a next generation display material.

- GIST (President Seung Hyeon Moon) – A research team led by Dr. Chang-Lyoul Lee of Advanced Photonics Technology Research Institute (APRI, Director Hyyong Suk) studied the optical characteristics of multi-dimensional perovskite materials to determine the principle of room temperature emission of perovskite quantum dots.

* Also known as titanium oxide, ABX3 is a metal oxide with a crystal structure that has not only the properties of an insulator, a semiconductor, but also a superconductor. It was first discovered in 1839 in the Ural Mountains of Russia and was named after the Russian mineralogist scientist Perovski. Pebroskite is emerging as a next-generation solar cell material that can replace silicon solar cells.

☐ Displays that displays visual information in everyday life, such as TVs or monitors, have recently developed more realistic colors that are closer to natural color through development of organic light emitting diodes (OLED) and quantum dot light emitting diodes (QLED).

- Perovskite, which attracted attention over the past few years in the field of solar cell based on its excellent optical and electrical characteristics, has been recently recognized as a next-generation display material to replace existing semiconductor materials based on its advantage of high efficiency and high color purity.

☐ For semiconducting materials to be used in displays, it must not only to have high efficiency and high color purity but also must emit light at room temperature. However, the polycrystalline thin film type perovskite used in solar cells has a low luminous efficacy at room temperature, which is a hindrance to its application as a display material.

☐ To improve the low luminous efficiency of the conventional polycrystalline perovskite thin film, the researchers developed a perovskite quantum dot of several nanometers in size with high efficiency at room temperature. By analyzing the luminescence characteristics according to the temperature, the principle of room temperature emission was identified.

- In general, a semiconductor material emits light by emitting light energy in the process of bonding electrons and ions in the material. Therefore, the better the combination of electrons and ions in a semiconductor material, the more its luminous efficiency increases. For perovskite quantum dots, which are only a few nanometers in size, both the electrons and ions are trapped within a space of a few nanometers, increasing the probability of bonding them. As a result, the luminous efficiency of the material is greatly improved, and the luminous efficiency can be high even at room temperature.

- The researchers quantitatively calculated the binding energy of electrons and ions by comparing the emission characteristics of perovskite quantum dots with polycrystalline thin films and single crystals. Perovskite quantum dots with high electron and ion binding energy showed higher luminescence efficiency than polycrystalline thin films and single crystals. However, the research also found that the perovskite quantum dots lose their emission efficiency at high temperatures compared to low temperatures because electrons and ions absorb heat energy and escape the quantum dots.

☐ Dr. Chang-Lyoul Lee said, "Perovskite quantum dots, which have both high luminescence efficiency and high color purity, are excellent next-generation display materials. We have quantitatively calculated the binding energy of electrons and ions in the perovskite quantum dots and found that the luminous efficiency decreases at high temperatures."

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