Simple fabrication of full-color perovskite LEDs
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Perovskite is a semiconductor material with a special structure containing metal and halogen elements. It is considered as a next-generation solar cell candidate because it has high photoelectric efficiency for converting sunlight into electricity. This material is also attracting attention as a light-emitting device because of its high luminous efficiency. Perovskite nanoparticles emit different colors depending on the internal halogen element. It emits red when it is rich in iodine, green when it is rich in bromine, and blue when it is rich in chlorine.

However, perovskite is highly sensitive, making it difficult to change elements stably. Now, Professor Kim has developed a simple technique to replace certain elements via a solution process. The method involves inducing element substitution using nonpolar solvent and chemical additives. "In the study, we added a nonpolar solvent containing iodine (I), bromine (Br) and chlorine (Cl) to a solution of perovskite nanoparticles," says Yung Jin Yoon in the Combined M.S./Ph.D Program of Energy Engineering, the first author of the study. "Once the reaction takes place, the elements mixed within the nonpolar solvent switches its place with elements in original perovskite, which causes changes in luminescence.

The added chemical additive serves to separate the halogen element present in the nonpolar solvent. As a result, the amount of halogen element in the solution increases, and over time, it is replaced with a halogen element in the conventional perovskite. The emission color is determined by the number of elements in the perovskite. The researchers also made LEDs with red, blue and green colors using perovskite nanoparticles produced with this technology.
Kim Ki-Hwan, a research professor in the Department of Energy and Chemical Engineering, said, "It is stable compared to the existing technology to change the element in the solid perovskite. It could be applied variously to change the element composition in the perovskite material."

"With our simple method, we obtained luminescence covering the entire visible spectrum from 400 to 700 nm," says Professor Kim. "Furthermore, saturated and vivid RGB LED devices were successfully fabricated using the anion-exchanged nanocrystals."


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