Scientists Synthesize Hafnium-based Vacancy Ordered Perovskite Nanocrystals by Hot Injection Method

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Researchers discovered that metal acetylacetonates are a very suitable kind of metal precursors. By using Hf-based vacancy ordered perovskite as a model system and hafnium acetylacetonate as a metal source, they synthesized Cs2HfCl6 nanocrystals for the first time by hot injection method.

Lead-free vacancy-ordered perovskite Cs2M4+X6 (X=Cl-, Br- or I-) nanocrystals have attracted much attention due to their low toxicity, high stability and unique optical properties.

In previously reported hot injection method for synthesizing perovskite nanocrystals, metal halides or metal acetates are often used as metal precursors. However, for many new perovskite nanocrystalline systems, the inability of these two types of metal salts to ionize in organic solvents is an important reason for synthesis failure.

Recently, a research group led by Prof. HAN Keli and Prof. YANG Bin from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) discovered that metal acetylacetonates are a very suitable kind of metal precursors. By using Hf-based vacancy ordered perovskite as a model system and hafnium acetylacetonate as a metal source, they synthesized Cs2HfCl6 nanocrystals for the first time by hot injection method.

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Different from previously reported perovskite nanocrystals, the newly-synthesized Cs2HfCl6 nanocrystal was a defect-intolerant semiconductor.

To mitigate the sub-band gap defect states inside Cs_2HfCl_6 nanocrystals, the researchers proposed a passivation strategy of Sb^{3+} doping, which had not been reported in previous perovskite studies.

Moreover, by using rare earth acetylacetonates, the researchers doped four rare earth ions, including Pr^{3+}, Tb^{3+}, Eu^{3+}, Ho^{3+}, into the crystal lattice of the Cs_2HfCl_6 nanocrystal host, and obtained tunable multicolor emissions.

Compared with the previously reported rare earth ions-doped perovskite nanocrystals systems, the use of rare earth acetylacetone compounds enabled rare earth element ions to be doped into the nanocrystals' lattice under a relatively milder temperature.

"Our study not only provides an effective strategy for regulating the optical properties of vacancy ordered perovskite nanocrystals, but also enriches the hot-injection synthesis method, which may promote the development of new perovskite nanocrystal systems," said Prof. HAN.