Researchers develop halide double perovskite ferroelectrics

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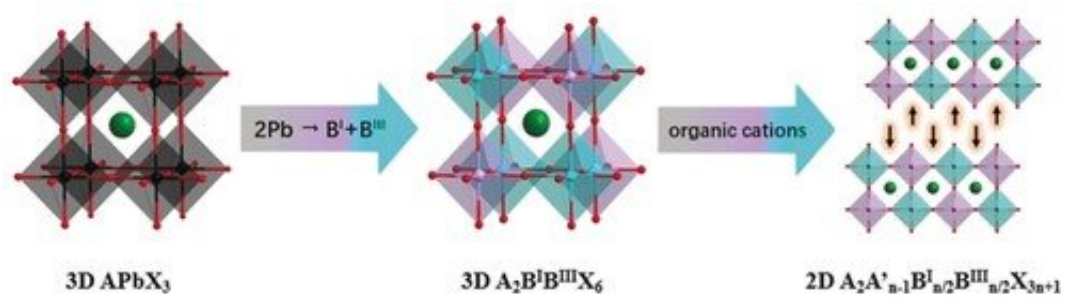

Schematic illustration of the metal-hetero-substitution and cation intercalation from 3-D lead halide perovskites to 2-D double halide perovskites. Credit: Prof. LUO's group

Halide double perovskites have proved to be a promising environmentally friendly optoelectronic and photovoltaic material, exhibiting inherent thermodynamic stability, high defect tolerance and appropriate band gaps. However, no ferroelectric material based on halide double perovskites has been discovered until now.

In a study published in *Angewandte Chemie International Edition*, a research group led by Prof. Luo Junhua from Fujian Institute of Research on the Structure of Matter (FJIRSM) of the Chinese Academy of Sciences reported the first halide double perovskite ferroelectric, (n-propylammonium)$_2$CsAgBiBr$_7$, which exhibits distinct ferroelectricity with a notable saturation polarization of about 1.5 μCcm^{-2}.

The researchers found (n-propylammonium)$_2$CsAgBiBr$_7$ through the metal-hetero-substitution and organic-cation intercalation of CsPbBr$_3$, which is a new environmentally friendly two-dimensional (2-D) halide double perovskite ferroelectric material.

They used a fascinating strategy, combining trivalent (Ga_3^+, Al_3^+, Tl_3^+, In_3^+, Bi_3^+, Sb_3^+) and monovalent metals (Rb^+, K^+, Na^+, Li^+, Ag^+, Tl^+) to replace two divalent lead cations (Pb_2^+), thus constructing a series of lead-free halide double perovskites.

Additionally, the researchers found that single-crystal photodetectors of (n-propylammonium)$_2$CsAgBiBr$_7$ exhibit extraordinary performance containing high on/off ratios of about 10^4, fast response rates of 141 μs, and detectivity as high as 5.3×10^{11} Jones. Such halide double perovskite ferroelectrics show high heat, light and moisture stability compared to lead perovskites.

This study opens a new way to design high-performance perovskite ferroelectrics, and provides a viable approach in the search for stable and lead-free optoelectronic materials as an alternative to the lead-containing system.

More information: Weichuan Zhang et al. The First Halide Double Perovskite Ferroelectric, *Angewandte Chemie International Edition* (2020). DOI: 10.1002/anie.201916254

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