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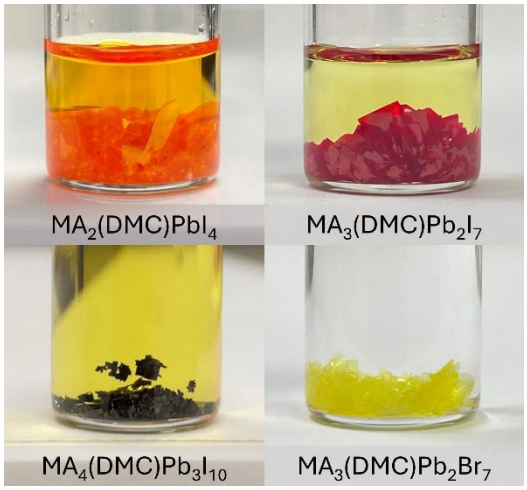
Designing Color-Changing Semiconductor Materials

Semiconductor materials known as 2D halide perovskites can be used in devices such as solar cells and light-emitting diodes. Scientists led by Assoc Prof Nripan Mathews of NTU's School of Materials Science and Engineering have synthesized four unique types of 2D halide perovskites.

Dr Ayan Zhumekenov, a research fellow at the school and lead author of the study, used a novel approach to create the new perovskites by incorporating dimethyl carbonate – a non-toxic solvent – into methylammonium-based perovskite crystals.



By analyzing the new crystal structures, the scientists discovered that the structures' band gap could be tuned by adjusting the ratio of methylammonium to dimethyl carbonate in them. The band gap, which determines the color of the material, is the energy required for an electron to break free from its bound state and become conductive.

The ability to engineer the width of the band gap is important for the various applications of perovskites.

The new 2D halide perovskites also exhibit a dynamic "switchable" behavior. The researchers found that one of the perovskites could switch between two colored states, changing from orange to red when heated to 80 degrees Celsius and reverting to its original color when cooled to room temperature.

The scientists demonstrated that the color-changing reaction could be repeated for 25 cycles. This phenomenon of thermochromic switching opens the door to applications such as smart coatings and heat-sensitive inks that change colour at different temperatures.

The scientists hope their innovation will pave the way for technological applications of 2D halide perovskites in optoelectronics and beyond.

The research was published in "Solvent-templated methylammonium-based Ruddlesden-Popper perovskites with short interlayer distances" in Journal of the American Chemical Society (2024), DOI: 10.1021/jacs.3c12891.

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