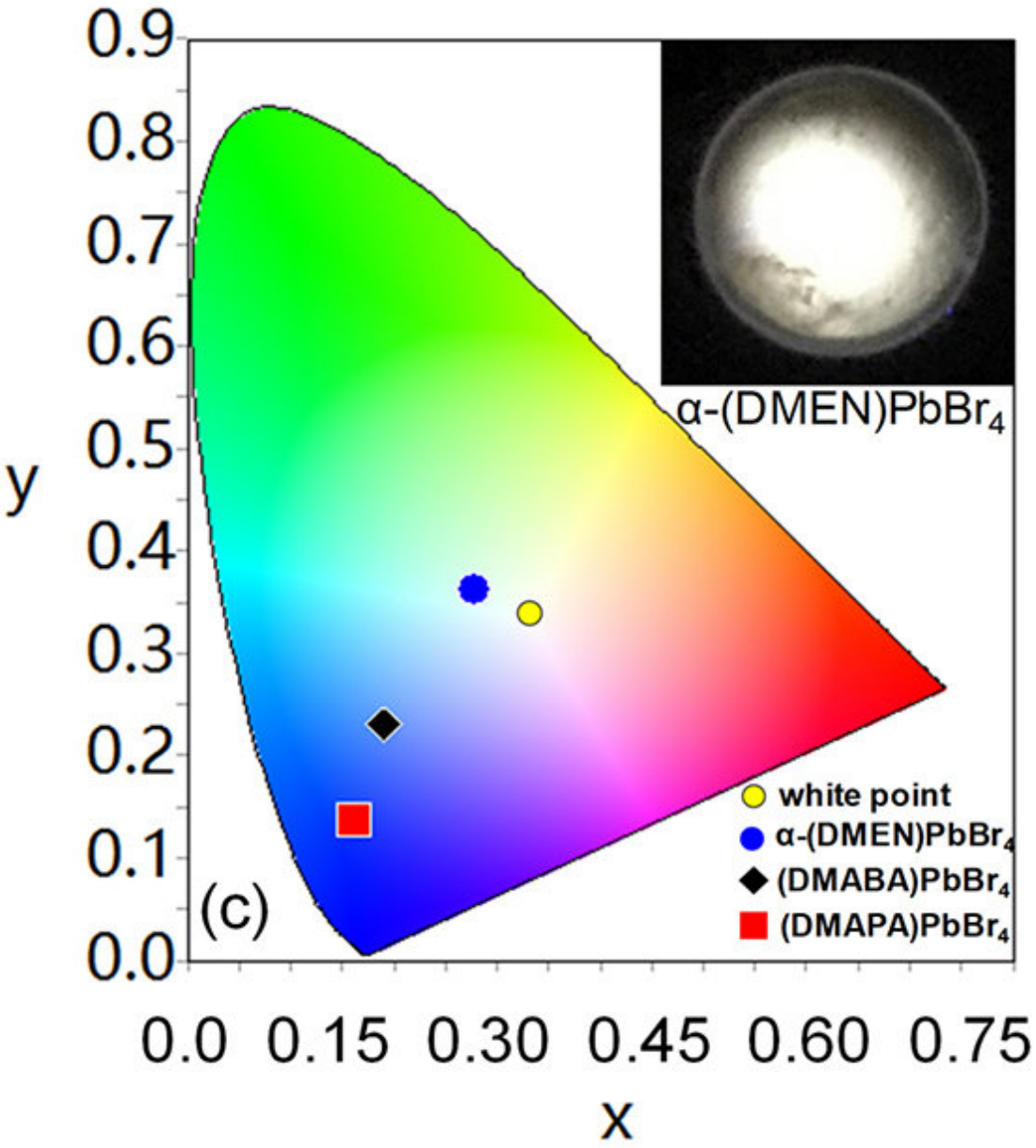
Modifying the internal structure of 2-D hybrid perovskite materials causes them to emit white light

November 1 2017



The color coordinate map illustrates the colors of light emitted by different hybrid perovskites (with varying degrees of internal structural distortion) relative to pure white (corresponding to the yellow circle). The insert is a photo of the white light emitted by the most distorted material in the study ((abbreviated a-(DMEN)PbBr4), also shown as a blue circle in the color map) after stimulation by ultraviolet radiation. Credit: US Department of Energy

Changing how we light our homes and offices could save energy, but new lighting technology requires new materials with the right properties. Materials called hybrid perovskites could be vital in making change possible. Scientists discovered that changing the length of small spacer ions located between the perovskite's internal layers manipulates the structure, distorting the layers to look like corrugated cardboard. The shortest spacer studied led to the most distorted structure. The structure emitted white light, comparable to commercial fluorescent lights.

A new design tool based on understanding how spacers alter the light emitted could lead to new materials. These materials could be the keys to next-generation light-emitting diodes and other devices that interconvert light and electricity, including solar cells.

White-light–emitting 2-D perovskites are attractive because of their low cost and tunability. Using different lengths of di-functional organic spacers, a series of new hybrid organic-inorganic lead bromide perovskites were synthesized by researchers at Northwestern University. Changing the length of the organic positively charged ions (cations) induces a distortion of the 2-D perovskite inorganic layers in the material, making the layers take on a wavy or corrugated structure. As the distortion caused by the different cation lengths increases, the

frequency bandwidth and the lifetime of the materials' photoluminescent emission increases. Having the largest internal distortion of all the materials prepared in this study, the compound a-(DMEN)PbBr4 emits white light with a color rendering index of 73, which is similar to a commercial fluorescent light source.

This correlation between structure and properties demonstrates that crystal structures of hybrid organic-inorganic perovskites can be manipulated to tune bandwidth and lifetime of the photoluminescent emission by varying the extent of the inorganic layer distortion. With abundant choices of organic molecules available, many new exciting perovskite materials can be prepared, leading to an even deeper understanding of the science of these materials and impacting optoelectronic applications such as solid-state lighting.

More information: Lingling Mao et al. White-Light Emission and Structural Distortion in New Corrugated Two-Dimensional Lead Bromide Perovskites, *Journal of the American Chemical Society* (2017). DOI: 10.1021/jacs.7b01312

Provided by US Department of Energy