Journal of
Materials Chemistry C

EDITORIAL

Cite this: *J. Mater. Chem. C*, 2022, **10**, 9667

Editor's choice collection on luminescent metal halides: here come halide perovskites and their derivatives

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DOI: 10.1039/d2tc90122f

rsc.li/materials-c

As one of the giant families in metal halides, lead-based halide perovskites represented by $MPbX_3$ (M = CH_3NH_3, Cs; X = Cl, Br, I) have appeared as fascinating luminescent materials in recent years, and show superior optoelectronic properties and versatile applications in solar cells, illumination, displays, lasers, detectors, sensors, *etc.* Generally, halide perovskites comprise ABX_3 (X = halogen) with six-coordinated metal halide octahedra connected with each other to form a three-dimensional (3D) structure, in which the A ion is usually an inorganic alkali cation, namely Cs^+ and Rb^+, or an organic ammonium cation such as $CH_3NH_3^+$ (MA^+) and $(NH_2)_2CH^+$ (FA^+), while the B site ion is a divalent metal ion such as Sn^{2+} and Pb^{2+}. However, according to the connectivity character of the BX_6 octahedra, such perovskite-type structures can be classified into various dimensionalities including three-dimensional (3D), two-dimensional (2D), one-dimensional (1D), and zero-dimensional (0D) at the molecular level, and thus we name those compounds with low-dimensional structural character (2D, 1D and 0D) as perovskite derivatives or metal halides. It is noteworthy that halide perovskites and their derivatives are a new generation of luminescent materials for emerging optoelectronic applications, as highlighted in this collection and summarized below.

Firstly, organic–inorganic hybrid halide perovskites have stunned the photovoltaic community in the past ten years. These materials have demonstrated unprecedented development in many aspects. Recently, the phase transition property in $FAPbX_3$ (X = Br, I) was theoretically investigated (DOI: **https://doi.org/10.1039/d2tc00559j**). Additionally, doping Sr into $FAPb_{1-x}Sr_xI_3$ quantum dots can lead to an increase in photoluminescence quantum yields (PLQYs) (DOI: **https://doi.org/10.1039/d0tc04625f**). Beyond hybrid halide perovskites, the all-inorganic halide perovskite $CsPbX_3$ has been widely studied at both the single-crystal and nanocrystal scales for different applications. For example, $CsPbBr_3$ single-crystals grown by an additive assisted method are applied to gamma-ray detection (DOI: **https://doi.org/10.1039/d0tc02706e**). $CsPbX_3$ nanocrystals have received more attention for display applications, and tunable emission was realized by selecting different halogens and/or changing the shapes, doping with exotic ions, *etc.* For instance, nano-wires were obtained through non-catalytic chemical vapor deposition growth (DOI: **https://doi.org/10.1039/d1tc00077b**). Lanthanide ion doping is reported to adjust the optical properties (DOI: **https://doi.org/10.1039/d1tc05506b**). Sodium doping can also lead to enhanced performance for $CsPbBr_3$ quantum dot-based electroluminescent light-emitting diodes (DOI: **https://doi.org/10.1039/d1tc05997a**). Based on the doping strategy, not only can the desirable emission color be realized, but the PLQYs can be enhanced to meet more requirements and applications. Moreover, encapsulating $CsPbX_3$ nanocrystals into metal–organic frameworks can enhance the stability, which produces a novel method for the preparation of composite materials with highly efficient luminescence in practical applications (DOI: **https://doi.org/10.1039/d2tc00075j**).

Secondly, low-dimensional perovskite derivatives, also called metal halides, have become state-of-the-art materials in terms of structural design, performance modification and different applications. For example, lead-free zero-dimensional hybrid or all-inorganic metal halides based on Cu^+, Mn^{2+}, Sb^{3+}, Bi^{3+}, In^{3+} and Te^{4+} have emerged as star materials with excellent luminescence for lighting applications (DOI: **https://doi.org/10.1039/d0tc00562b**; **https://doi.org/10.1039/d0tc05752e**; **https://doi.org/10.1039/d1tc05140g**; **https://doi.org/10.1039/d1tc01037a**; **https://doi.org/10.1039/d1tc05680h**). The toxicity of lead halide perovskites can be avoided as well. Moreover, the applications of luminescent metal halides have also been extended

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to solar cells, X-ray detection, and photocatalysis. Recent reports show that Cs_2SnI_6/ZnO heterojunctions can be employed as high-performance UV-visible dual-band photodetectors (DOI: https://doi.org/10.1039/c9tc05940g). PEA_2SnBr_4 shows impressive water-stability and functions as a co-catalyst in hydrogen photogeneration and organic-dye degradation (DOI: https://doi.org/10.1039/d0tc02525a). Additionally, polycrystalline $Cs_3Bi_2I_9$ was reported to exhibit ultralow-detection-limit X-ray detection (DOI: https://doi.org/10.1039/d2tc00599a). 2D halide perovskites show good optoelectronic properties (DOI: https://doi.org/10.1039/d0tc04250a), and Ruddlesden–Popper 2D perovskites are reported to function as Li-ion battery electrodes (DOI: https://doi.org/10.1039/d1ma00020a).

Thirdly and finally, considering the multi-functional properties of metal halides, a large number of reviews have also been published to summarize the basic thermal properties and optical properties (DOI: https://doi.org/10.1039/d0tc03754k). However, water-stability and thermal stability are still the key points for the future study of metal halides. In the future, searching for and exploring metal halides with excellent water and thermal stability as well as excellent optical properties remains challenging and significant. By carefully selecting published articles from *Journal of Materials Chemistry C* and *Materials Advances* into a themed collection, I hope that the charming and the rich performances of luminescent metal halides can be witnessed by chemists, physicists, and materials scientists. I would like to thank all the authors for their excellent research, the reviewers and the editorial staff for their careful and hard work during publication. I hope this collection could motivate novel research and promote positive developments to make more progress in luminescent metal halides for optoelectronic applications.

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