frontiers in Materials

EDITORIAL
published: 06 July 2021
doi: 10.3389/fmats.2021.717830

Editorial: Advances in Perovskite Materials for Optoelectronic Applications

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Keywords: photovoltaics (PV), light emitting diodes, optoelectronics, perovskites, Scalability, flexibility, carrier transporting layers

Editorial on the Research Topic

Advances in Perovskite Materials for Optoelectronic Applications

The class of halide perovskite materials has been widely used in optoelectronics. The application of halide perovskites in solar cells has made a significant breakthrough in the field of emerging photovoltaic (PV) technologies since the last decade. The power conversion efficiencies (PCEs) of perovskite based solar cells (PSCs) have shown a remarkable increase from the pioneering value of 3.8% in 2009 to the recent record of 25.5 and 29.5% for the single junction device and the tandem with silicon (Si) respectively. Beyond the field of PV, the three-dimensional halide perovskites and their low-dimensional counterparts have been also widely explored for applications in light emission. The metal halide perovskites are promising luminescent materials as they exhibit a high photoluminescence (PL) quantum yield reaching 100% as well as narrow and symmetric PL peaks which can be tunable all over the visible spectral range. In just a few years, the external quantum efficiencies of the green- and red-emitting devices have been enhanced over 20%. Despite the promising optoelectronic properties of this class of materials, a number of challenges such as material instability, short device lifetime, processing difficulties in preparation of perovskite materials in a large scale and on flexible substrates etc. have still not been completely solved before the stage of commercialization. Over the years, the community has devoted intensive attentions to investigating the properties of this class of materials as well as understanding their device physics and a lot of effective strategies for overcoming the aforementioned challenges have been demonstrated with very promising results. The Research Topic entitled **Advances in Perovskite Materials for Optoelectronic Applications** of Frontiers in Materials has a collection of 6 articles focused on discussing the recent development of halide perovskite-based materials for applications in solar cells and light emitting diodes.

The enhancement of material stability and device lifetime for high efficiency PSCs is of significant interest. Ge et al. reviewed the recent progress of 2D/3D multidimensional metal halide PSCs. Adopting 2D/3D heterojunction perovskite as the light absorber in PSCs is shown to be an effective technique in stabilizing the devices while a high PCE can be still retained or further enhanced. This review article summarized different approaches of constructing 2D/3D multidimensional PSCs and pointed out the current challenges as well as the prospective of this type of PSCs.

Edited and reviewed by:
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Specialty section:
This article was submitted to Energy Materials, a section of the journal Frontiers in Materials

Received: *31 May 2021*
Accepted: *22 June 2021*
Published: *06 July 2021*

Citation:
Ng A, Jumabekov AN, Yang S, Zapien JA and Surya C (2021) Editorial: Advances in Perovskite Materials for Optoelectronic Applications. Front. Mater. 8:717830. doi: 10.3389/fmats.2021.717830

Along with the development toward future industrial manufacturing, the scalability and impacts of ambient conditions for device fabrication should be well addressed. Fong et al. comprehensively reviewed the recent advances of preparing halide perovskites in ambient air while considering the impact of moisture on the crystallization of perovskite thin films. The technology transfer from the spin coating to scalable blade coating is also thoroughly discussed including the comparison of the deposition dynamics, drying mechanism as well as the processing window etc. This article provides the community with useful insight into upscaling PSCs in the ambient air condition.

The establishment of technology for fabricating flexible PSCs (FPSCs) is important for future commercialization as this type of PSCs opens up the opportunities of applying them in wearable electronics and building integrated photovoltaics (BIPV). Liang et al. summarized the latest developments of FPSCs. The review compared a variety of flexible substrates and electrodes, and highlighted the fabrication techniques for high-quality perovskite films on flexible substrates. The challenges and prospective for massive manufacturing of FPSCs were also discussed.

To achieve high-performance PSCs, the quality of other functional layers such as charge transporting layers (CTLs) are also very crucial. Singh et al. summarized the development roadmap of high-performance PSCs based on different common metal oxide CTLs. The article also explained the criteria of effective metal oxide CTLs as well as the widely used deposition methods of these CTLs.

In recent years, the development of perovskite-based light-emitting diodes (PeLEDs) is also very promising. Ge et al. reviewed the recent advances of different dimensional perovskites (3D, 2D, quasi-2D and nanocrystals) used for blue-emitting PeLEDs. The performance of different blue-emitting PeLEDs was also evaluated, providing the latest update on the research progress of this type of PeLEDs.

The research article of Afanasyev et al. reported the effect of plasmonic nanostructures on the optical properties of perovskite films. Their results indicate that the silver nanostructure can increase the emission intensity of PeLEDs and prolong the lifetime of charge carriers in perovskites, which is desirable for photovoltaic application.

This Research Topic collects the articles with the latest progress in the perovskite community. The editors thank all authors and reviewers for their contributions and hope these works will provide good directions for the community to accelerate the development of perovskite-based optoelectronics toward future commercialization.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.