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SPEAKER

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TITLE

Lead Halide Perovskites for Next Generation Photovoltaics

ABSTRACT

Metal halide perovskites have drawn significant attention in recent years because of its ability to deliver high efficiency solar cells.^{1,2} Efforts are now being directed towards the design tandem solar cells to boost the efficiency beyond single crystal silicon solar cells.³ However, barriers to transform laboratory scale devices to large scale commercial technology remain. Unusual excited state properties of these materials are also creating new opportunities to explore optoelectronic applications.

Mixed halide lead perovskites with continuous tuning of the semiconductor bandgap are regarded as possible candidates for such applications.³⁻⁴ By varying the halide ion composition of methylammonium lead iodide/bromide ($\text{CH}_3\text{NH}_3\text{PbBr}_x\text{I}_{3-x}$ ($x=0$ to 3)) it is possible to tune the bandgap between 1.55 eV and 2.43 eV. In addition to photovoltaic applications these mixed halide perovskites offer rich photophysical properties with applications in lasing and optoelectronic devices. An intriguing property of mixed halide lead perovskites (e.g., $\text{CH}_3\text{NH}_3\text{PbI}_{3-x}\text{Br}_x$) is phase segregation to create iodide-rich and bromide-rich regions under visible irradiation.^{5,6} The halide ion movement in mixed halide films can be tracked from the changes in the photoluminescence and absorption spectra. Photoinduced segregation in mixed halide perovskite has a direct influence on decreasing the solar cell efficiency as segregated I-rich domains serve as charge recombination centers. The recovery of loss in the external quantum efficiency mirrors the dark recovery of the absorption showing the reversibility of the photoinduced halide segregation. Implication of such halide ion migration in mixed halide perovskite solar cell will be discussed.

Related Readings

1. Manser, J. S.; Saidaminov, M. I.; Christians, J. A.; Bakr, O. M.; Kamat, P. V., Making and Breaking of Lead Halide Perovskites. *Accounts of Chemical Research* **2016**, *49*, 330-338.
2. Manser, J. S.; Christians, J. A.; Kamat, P. V. Intriguing Optoelectronic Properties of Metal Halide Perovskites. *Chem. Rev.* **2016**, *116*, 12956-13008.
3. Kamat, P. V., Hybrid Perovskites for Multijunction Tandem Solar Cells and Solar Fuels. A Virtual Issue. *ACS Energy Lett.*, **2018**, *3*, 28-29
4. Hoffman, J. B.; Schleper, A. L.; Kamat, P. V., Transformation of Sintered CsPbBr_3 Nanocrystals to Cubic CsPbI_3 and Gradient $\text{CsPbBr}_x\text{I}_{3-x}$ through Halide Exchange. *J. Am. Chem. Soc.* **2016**, *138*, 8603-8611.
5. Draguta, S.; Sharia, O.; Yoon, S. J.; Brennan, M. C.; Morozov, Y. V.; Manser, J. M.; Kamat, P. V.; Schneider, W. F.; Kuno, M. Rationalizing the light-induced phase separation of mixed halide organic-inorganic perovskites. *Nat. Commun.* **2017**, *8*, Article No. 200 (DOI: 210.1038/s41467-41017-00284-41462).
6. Yoon, S. J.; Kuno, M.; Kamat, P. V. Shift Happens. How Halide Ion Defects Influence Photoinduced Segregation in Mixed Halide Perovskites. *ACS Energy Lett.* **2017**, 1507-1514.