Interactions between 2D Halide Perovskite Materials and Methylamine

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Introduction

The structural tunability of halide perovskites, shown below, offers exciting potential for their use as photovoltaic materials and as semiconductors in diverse applications. We investigate 2-dimensional Ruddlesden-Popper (RP) phase halide perovskite structural stability by the intercalation-deintercalation of methylamine gas.

![Structure of the 3D ABX₃ halide perovskites shown at left. A 2D Ruddlesden-Popper phase perovskite shown at right along with an intermediate 2D/3D phase (center).](Image)

Switchable Windows

- Photo-thermal heating can lead to switchable MAPbI₃ solar cells in the presence of MA gas
- Switchable PV circumvents the fundamental efficiency-transparency tradeoff of PV windows
- Morphological changes lead to degradation

![Schematic of switchable PV window operation (top). Photocurrent of devices with time for 20 switches (bottom).](Image)

Project Goal: Evaluate interactions between A-site organic spacers and lead halide sheets in 2D perovskites.

Key Findings:

- Incorporation of MA in PEA₂PbI₄ and 4-F-PEA₂PbI₄ forms stable A₂MA₁PbI₃
- MAPbI₃ phases appear to form initially EA₂PbI₄ materials after MA exposure

![Chemical structure of A-site organic cations used in this work.](Image)

Improved Stability

- Stability gains realized for mixed 2D/3D materials
- Can reduce moisture sensitivity
- Improvement mechanism still unclear

![Operational stability comparison of 3D (blue) and mixed 2D/3D halide perovskite solar cells.](Image)

Conclusions

- n = 2 materials preferentially formed (vs. n=1 or n>2) upon MA exposure
- Yields insight into hierarchical structures in some mixed 2D/3D perovskites (regions of 3D and low dimensionality materials).
- Exploration of other A-site cations to improved design rules for mixed 2D/3D halide perovskites

References


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