Energy Materials Lab

PI: Dr. Juan-Pablo Correa-Baena

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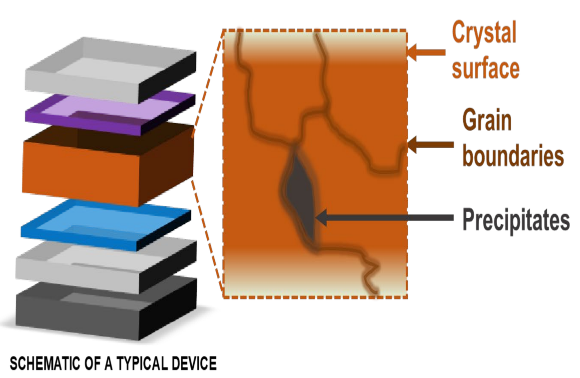
- Juan-Pablo Correa-Baena joined Georgia Tech in the Spring of 2019. His group focuses on the understanding and control of electronic dynamics at the nanoscale for low-cost semiconductors, such as halide perovskites and other materials.
- Juan-Pablo received his PhD from the University of Connecticut, where he studied metal oxide aerogels as porous conductive electrodes for dye-sensitized solar cells, funded by two National Science Foundation fellowships.
- His work as a postdoctoral fellow at the Ecole Polytechnique Fédérale de Lausanne focused on understanding of fundamental questions regarding band alignment at interfaces and their influence on performance in perovskite solar cells.
- His work at MIT shed light onto minority phase formation and elemental distribution in complex, multi-element halide perovskites, which determine the efficiency of the solar cells. His contributions have ultimately helped boost the efficiencies of perovskite solar cells above 25%.

Research Focus

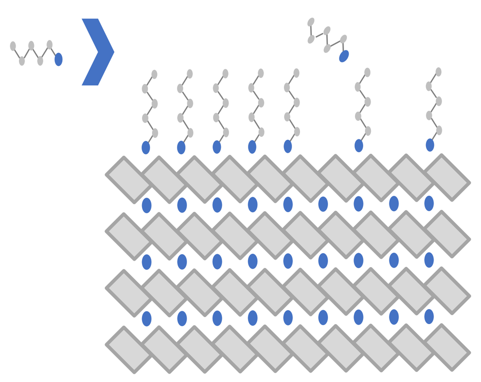
Understand



The role of interfaces and of 2D and 3D defects in low-cost semiconductors

- Advanced X-ray and neutron characterization

Design



Device fabrication with monolayer control and large area uniformity

- Vapor deposition of perovskites and charge extraction layers

Evaporation

- Scalability remains an obstacle towards commercialization of perovskite solar cells (PSCs)
- PSCs are composed of many layers traditionally deposited via spin-coating
- Use of solvents remains an issue due to concerns over toxicity, low solubility of precursors, and potential dissolving of underneath layers
- Our research is focused on fabrication of PSCs by physical vapor deposition (thermal evaporation techniques)
- Benefits of thermal evaporation include high purity films, large area compatibility, and better thickness control

  Coevaporation of perovskite precursors allows for control over the resulting stoichiometry

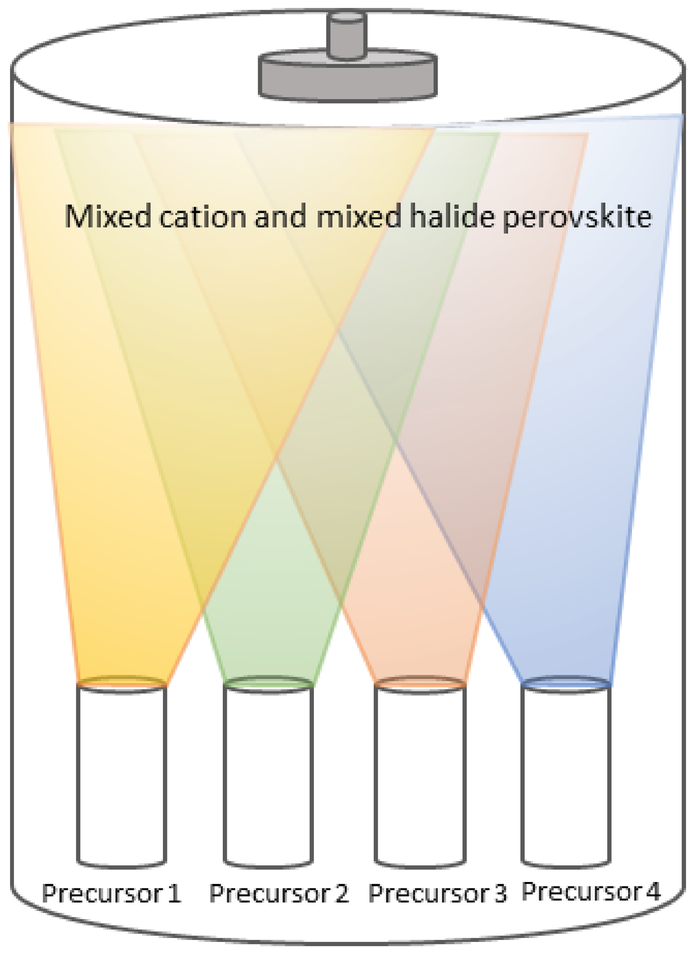


Figure 1. Coevaporation of mixed cation and mixed halide perovskites

Andres Felipe Castro Mendez

Carlo Perini

Atomic Layer Deposition

- Atomic layer deposition (ALD) allows for uniform deposition of very thin films with angstrom-level thickness control
- Sequential, self-limiting process (see **Fig. 2**)
- Allows for deposition of thin passivation layers
- Our research focuses on the design of an ALD process for the deposition of lead iodide and perovskite
- Another aim is the optimization of charge transport layers

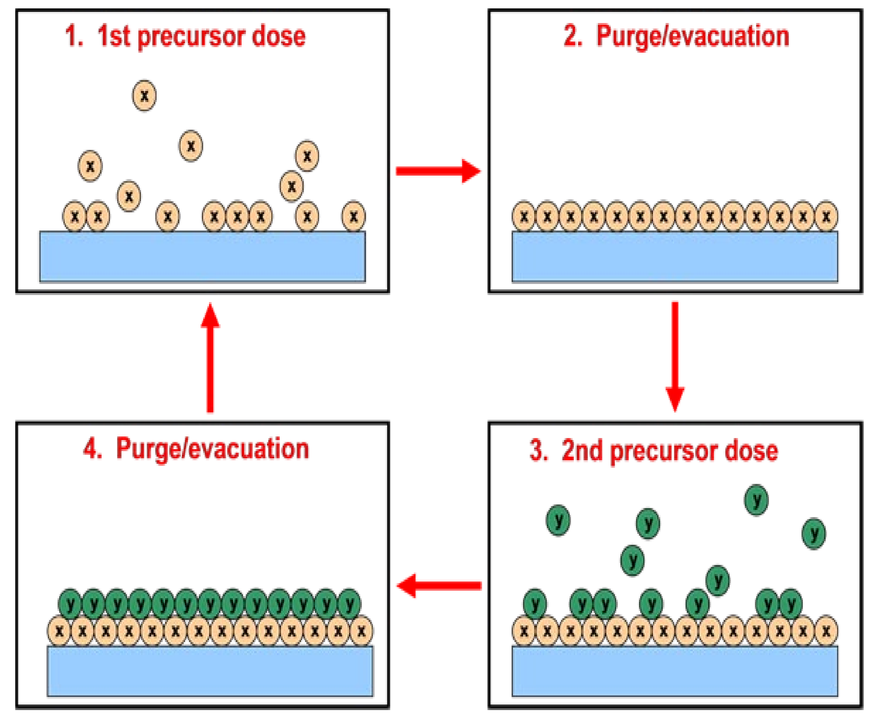


Figure 2. A typical ALD process (Kurt J Lesker Company)

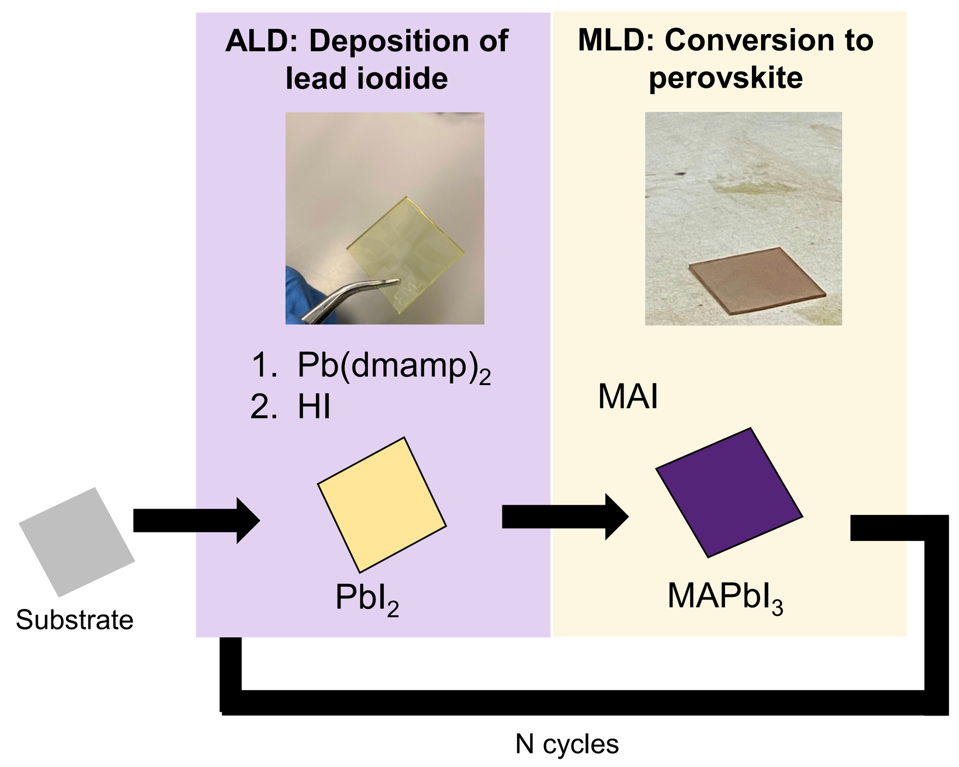
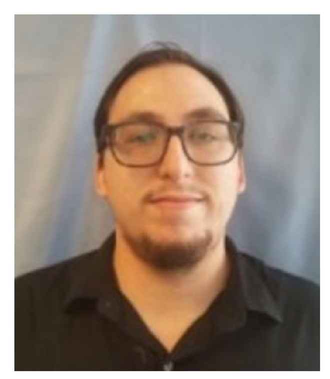


Figure 3. ALD/MLD of perovskite

Jake Vagott

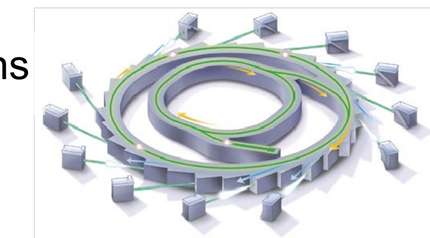


Synchrotron

Advanced characterization techniques

Neutrons

X-Ray



UNDERSTANDING
Molecular
Micro

Macro: PEROVSKITE SOLAR CELL

- GIWAXS/GISAXS
- Hybrid organic-inorganic perovskites are promising for solar cell applications due to their high conversion efficiency
- Using neutron and synchrotron advanced characterization techniques, a deep analysis of the material can be realized including the following information:
  - Material structure
  - Chemical state/bonding
  - Elemental distribution
  - *In-situ* changes due to environmental conditions

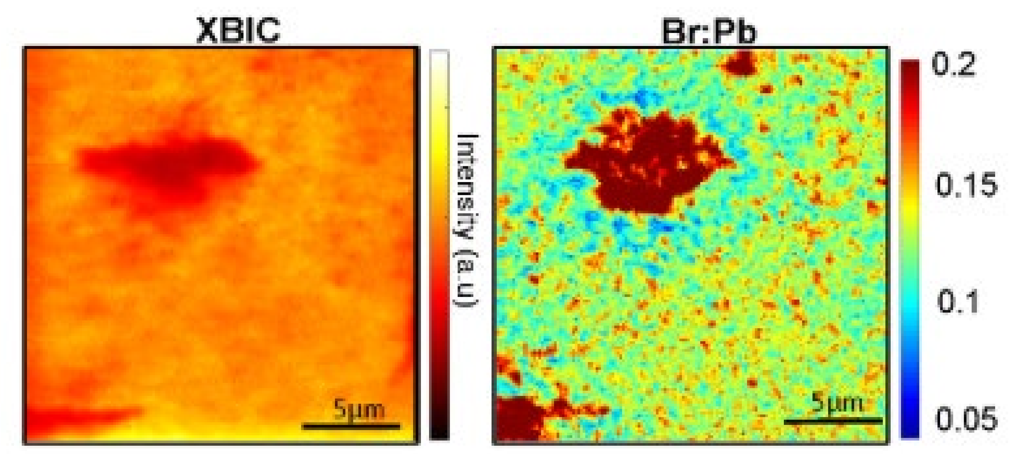


Figure 4. XBIC and XRF ratio of Br:Pb in a triple cation CsMAFA perovskite (Experiment done at beamline 2ID-D at the APS at Argonne National Laboratory)

Juanita Hidalgo

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