Dr. 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.

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)

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

Synchrotron
- 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 1. Coevaporation of mixed cation and mixed halide perovskites

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

Figure 3. ALD/MLD of perovskite

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)

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