Contribution ID: **300**

Type: **Poster**

How does strain influence the performance in polycrystalline solar cells at the nanoscale?

Tuesday, 18 September 2018 17:15 (15 minutes)

Polycrystalline solar cells offer numerous advantages over their single crystalline counterparts, including lower cost, higher flexibility, and ease of fabrication. Unfortunately, polycrystalline cells are less efficient at converting sunlight into electrical power. Grain boundaries (GBs) are generally accepted as the cause of this efficiency differential because they act as recombination centers and induce voltage inhomogeneities. While GBs have been explored, the role of strain and its impact on local efficiency remains a potential avenue for improving efficiency in polycrystalline thin films.
For this study, we have utilized the hard X-ray nanoprobe (HXN) at NSLS II to measure simultaneously and operando the performance, elemental distribution, and strain via X-ray beam induced current (XBIC) and voltage (XBIV), X-ray fluorescence, and X-ray diffraction.
We find a positive correlation between the local strain and X-ray beam induced current and voltage in industrially manufactured Cu(In,Ga)Se2 grains in a correlative microscopy approach. In grains with low angle tilt boundaries, the connection between strain and XBIC is unclear, likely due to the confounding influence of low angle GBs. Our correlative microscopy approach opens a new avenue for exploring the impact of strain, defects, and morphology on solar cell performance at the individual grain level and points to strain engineering as a potential direction for improving solar cell efficiency.

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Session Classification: Poster session 2

Track Classification: P6 Nanomaterials and nanostructures