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Spatially resolved composition and functionality of thin film solar cells

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Kesterite $Cu_2ZnSnSe_4$ (CZTSe) and chalcopyrite $CuIn_xGa_{1-x}Se_2$ (CIGS) absorber materials can form high efficiency thin film solar cells. They feature a number of different polycrystalline layers with thicknesses of 10 nm up to several µm. Compositional variations of the absorber layer can limit their conversion efficiency. High resolution, spatially resolved investigations enable insights into such compositional and functional variations by applying X-ray fluorescence (XRF) and X-ray beam induced current (XBIC) measurements, respectively. Simultaneous XRF and XBIC measurements of complete solar cells were conducted in plan-view geometry: The highly focused X-ray beam at the ID16B-NA station of the ESRF scanned the cell and by analyzing the emitted fluorescence radiation and current signal we obtain corresponding maps. As the spatial resolution is about 50 nm, we can show how different grains, grain boundaries and/or different elemental compositions influence the measured current. Compared to other methods, like electron beam induced current (EBIC), complete solar cells can be investigated with high lateral resolution. Combining XRF and XBIC with scanning electron microscopy (SEM) images allows the spatial correlation of energy conversion efficiency and structural/compositional variations of the absorber.

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