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Research Interests

Single or multi-junction thin film solar cells based on $Cu(In,Ga)Se_2$, CdTe, and perovskite semiconductors.

Metal oxide thin films as transparent conductive layers, surface passivation, diffusion barriers, or buffer layer for energy band alignment.

Solid state electrolytes and high potential cathodes for all-solid-state batteries.

Advanced characterization methods of layers and interfaces, especially structural, chemical, optical and electrical properties.

Insights to high efficiency CIGS thin-film solar cells and tandem devices with Perovskites

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CIGS, Perovskite, Tandem, Solar Cells, Thin Film

Solar modules with power conversion efficiency beyond 20% produced by large area thin film deposition equipment will enable cost efficient solar electricity. The recent achievements on the development of low temperature processed $Cu(In,Ga)Se_2$ (CIGS) based solar cells with focus on the role of alkaline treatments will be discussed in this contribution. Further the combination of the CIGS cells with the hybrid organic-inorganic perovskite cells in tandem configuration will be presented.

Proper control of alkaline elements added to the CIGS absorber layer is a key aspect for the processing of high efficiency solar cells. Recently, we introduced a modified alkaline treatment of the absorber layer grown at low temperature, allowing the processing of flexible and lightweight devices with 20.4% efficiency and more importantly enabling a leap for the entire community. Insights on the mechanisms will be presented.

The high efficiency of perovskite solar cells coupled with the large bandgap (tunable up to 2.3 eV) makes them ideal candidates as top cells in all-thin-film tandem devices with $Cu(In,Ga)Se_2$ (CIGS) as bottom cell. The development of NIR transparent top cell architectures is a prerequisite for successful development of highly efficient tandem devices. We present hysteresis-free semi-transparent planar perovskite solar cells with remarkably high steady-state efficiency of 17% and discuss performance stability and possibilities for further efficiency improvements. In combination with low bandgap CIGS bottom cells we demonstrate conversion efficiency approaching 23% in 4-terminal tandem configuration.