The Renaissance of Selenium Thin-Film Solar Cells

The Elemental High Bandgap Photoabsorber

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MRS 2023 Spring Meeting – Abstract

The renaissance of selenium thin-film solar cells – the elemental high bandgap photoabsorber

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In the pursuit of lowering the cost and increasing the penetration of solar energy technologies, a family of inorganic thin-film photovoltaic materials is emerging. The oldest member of this family, selenium, is experiencing renewed interest due to its high bandgap of 1.95 eV in its trigonal phase, as well as its irresistible monoatomic simplicity. The high bandgap makes selenium a potential partner in tandem photovoltaic devices featuring e.g., silicon as the lower bandgap photoabsorber, but high-efficiency selenium thin-film solar cells have yet to be realized.

We present selenium thin-film solar cells with power conversion efficiencies exceeding 5% and following a novel optimization of the carrier-selective contacts, we demonstrate a record open-circuit voltage of 0.99V and highly encouraging fill-factors beyond 60%. These state-of-the-art devices are investigated in a combined experimental and first-principles study to reveal the origin of the still-significant photovoltaic losses. In view of these results, we set forth strategies for continued improvements to the photovoltaic performance by means of non-equilibrium growth and defect engineering.