Preliminary Development of Selenium-Silicon Tandem Solar Cells

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Abstract

Tandem solar cells (TSCs) represent an innovative approach in photovoltaic (PV) technology by stacking multiple cells with varying bandgaps, which improves light collection and leads to higher efficiencies. Silicon-based TSCs, combining silicon with wide-bandgap materials, offer a promising pathway to achieving high efficiency at lower costs. Notably, Si-perovskite tandem cells have recently reached record efficiencies of 33.9 %, though challenges such as long-term stability and scalability still need to be addressed for industrial-scale implementation.
Selenium (Se), one of the oldest photovoltaic materials, is an intriguing option for use in tandem structures with silicon. This non-toxic and abundant chalcogenide has attracted attention due to its high absorption coefficient (~10^5 cm^{-1}), wide bandgap, and compatibility with low-temperature deposition. This study presents our preliminary results on the development of selenium-silicon tandem solar cells. Planar passivated emitter and rear contact (PERC) silicon (Si) solar cells, with indium tin oxide (ITO) as a transparent front contact, and bifacial selenium (Se) solar cells were prepared separately and physically bonded using a custom-designed clamping tool. The observed tandem effect includes an open-circuit voltage (Voc) of 1.17 V and an efficiency exceeding 5%. Currently, monolithic cells are under development to enable the direct growth of the Se top cell on the Si bottom cell with a tunnel junction, aiming to minimize losses and improve overall efficiency.

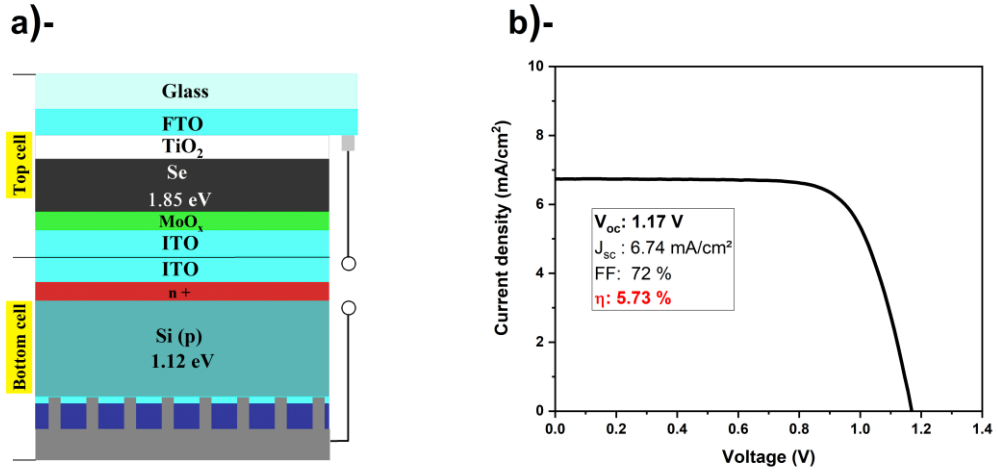

Figure 1 Schematic Representation of the Selenium-Silicon Tandem Solar Cell Structure (a) and the Corresponding Current-Voltage (J-V) Curve