Docket #: S23-050

High-efficiency transition metal dichalcogenide solar cell fabrication

Stanford researchers in the Pop Lab in conjunction with IMEC, Belgium developed a scalable, mass-production-friendly process method for high-quality, multilayer transition metal dichalcogenide (TMDs) films based on selenization/sulfurization of transition metals/metal oxides. Due to their desirable band gaps and high absorption coefficient, TMDs are promising for next generation, high specific power solar cells. Current TMD fabrication methods rely on exfoliating small flakes from a bulk TMD crystal, which does not produce full, mass production friendly, multi-layer films.

The Pop Lab deposited wafer-scale, multilayer tungsten diselenide (WSe_2) films by selenizing pre-deposited, pre-patterned tungsten with solid source selenium and H2Se precursors (See Fig. 1). These WSe2 films yield a charge carrier lifetime of up to 144 ns, corresponding to power conversion efficiency of ~22% and specific power of ~64 W g-1 in a packaged solar cell, and ~3 W g-1 in a fully packaged solar module. Initial focus was WSe_2, but the method could be applied to sulfur (instead of selenium), and other transition metals or even other transition metal oxides (e.g. WSe_2, WS_2, $MoSe_2$, MoS_2). This breakthrough could pave the way for mass-production of low cost, high-efficiency, lightweight, flexible, multilayer WSe2 (and other TMD) solar cells that are capable of irregular shapes like a drone wing, car roof, or wearable devices. Alternatively, layered TMDs could be used as contact layers for CdTe and CIGS solar cells.

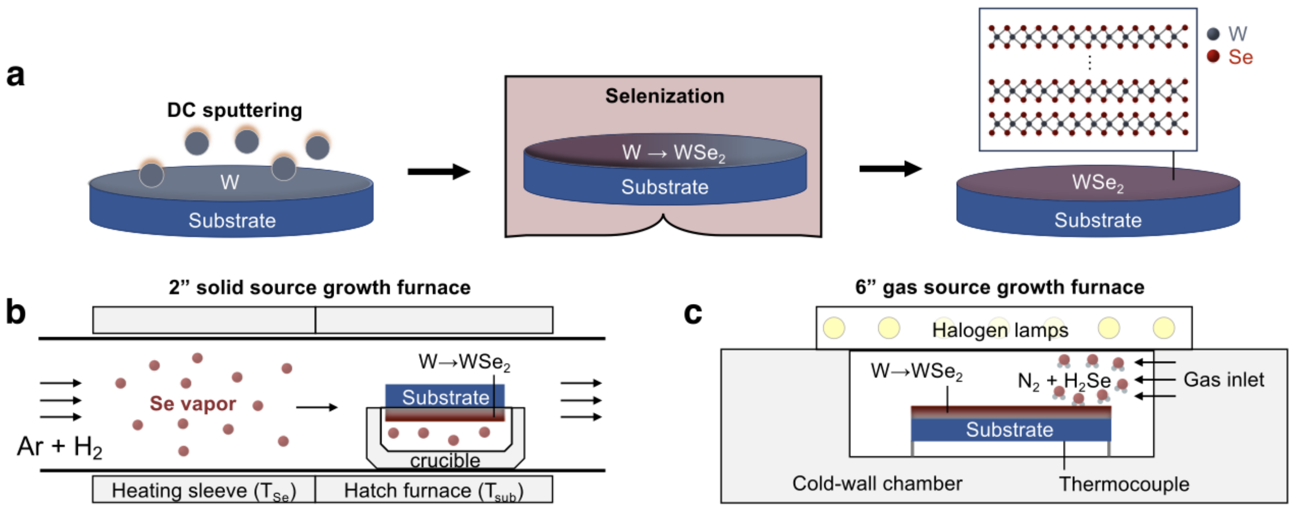

Figure 1 Wafer-scale, multilayer tungsten diselenide (WSe_2) film deposition schematic

Image courtesy the Pop Lab

Stage of Development - Prototype

Applications

- Ultra-thin, high-specific-power, transition metal dichalcogenide (TMD) **solar cells** for drones, low-earth-orbit satellites, electric vehicles, and wearable electronics.
- Contact layer for CdTe and CIGS solar cells

Advantages

- **Multilayer, uniform, full coverage, large-area** TMD films as required for **high performance solar cells.**
- **Mass-production friendly** film quality, stability, reliability, scalability, and low cost
- **Ultra-thin, lightweight, flexible, with high absorption** – compared to other solar materials, TMDs absorb ultra-high levels of sunlight.

Publications

- Neilson, K. M., Hamtaei, S., Nazif, K. N., Carr, J. M., Rahimisheikh, S., Nitta, F. U., Brammertz, G., Blackburn, J. L., Hadermann, J., Saraswat, K. C., Reid, O. G., Vermang, B, Daus, A., & Pop, E. (2024). Toward Mass-Production of Transition Metal Dichalcogenide Solar Cells: Scalable Growth of Photovoltaic-Grade Multilayer WSe2 by Tungsten Selenization. *arXiv preprint arXiv:2402.08534.*
- New solar materials could usher in ultrathin, lightweight solar panels

Innovators

- Katie Neilson
- Koosha Nassiri Nazif
- Alwin Daus
- Eric Pop
- Sarallah Hamtaei

Licensing Contact

Evan Elder

Senior Licensing Associate

Email