Docket #: S18-187

Low Cost Silicon (Si)/Transition Metal Dichalcogenides (TMDs) Tandem Solar Cells with goal of >30% Efficiency

Stanford researchers have developed a method to fabricate highly efficient Si/TMDs tandem solar cells which aims to break the 30% efficiency barrier with low cost and increased reliability. The TMD solar cell is integrated with a Si cell using band engineered metal oxides as carrier selective heterojunction contacts, enabling low temperature processing. The resulting photovoltaic (PV) cell is composed of two independently operating sub-cells of TMD and Si. Since each sub-cell is independent of the other, no current lattice matching is required and each sub-cell can be optimized for maximum efficiency. Ultrathin TMD solar cells on Si also provides a pathway for integration on Si chips for energy harvesting that is critically dependent on efficient light absorption in an ultrathin layer - something that TMDs are well-known for.

This invention has the potential to significantly reduce the price per watt as well as the levelized cost of electricity (LCOE) of commercial solar cells by increasing their efficiency to above 30% without increasing costs. This novel tandem solar cell has the potential to replace the current silicon solar cell technologies which dominates the solar market.

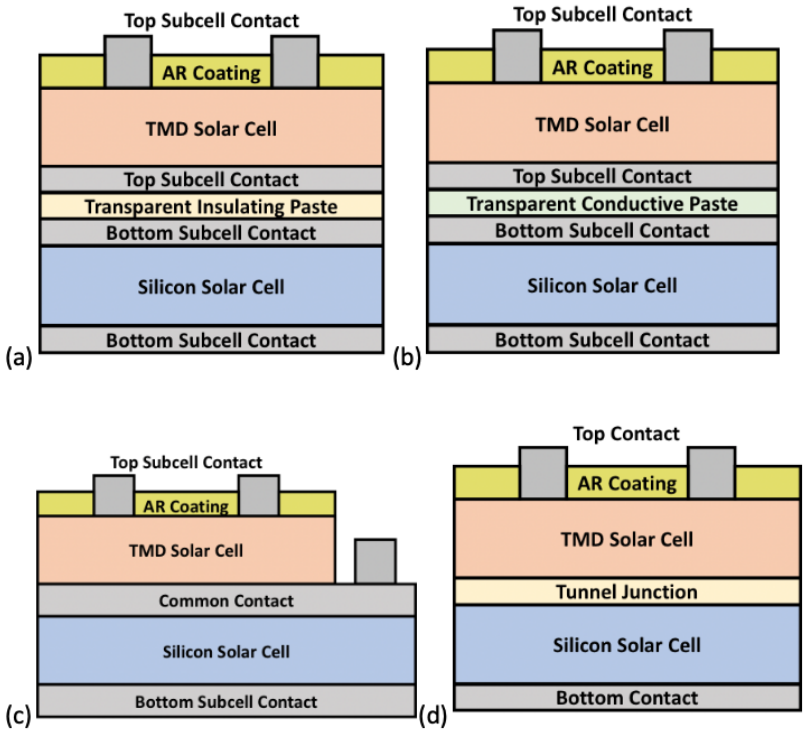

Figure description - Schematics of (a) mechanically stacked, four-terminal, (b) mechanically stacked, three- terminal, (c) monolithically integrated, three-terminal, and (d) monolithically integrated, two- terminal TMD/Si tandem solar cells

Stage of Research

- Early prototypes
- Lab simulations demonstrated high power conversion efficiency >30%

Applications

- **On-chip energy harvesting for**Internet-of-Things (IoT) sensors (projected to be scaled to trillions in 2020s)
- Residential/Commercial/Utility solar panels

Advantages

- **Higher power conversion efficiency >30%**

- **Lower manufacturing cost** since thermal steps for the formation of p-n junctions are eliminated
- **Lower temperature processing**
- **Lower levelized cost of electricity (LCOE)** and thus the potential to disrupt the solar market
- **No lattice matching is required** since sub-cells are independent of each other
- Each independent sub-cell can be optimized for **maximum efficiency**
- **The concept is not limited to TMD on Si** but generally applicable to other layered materials such as graphene or black phosphorus on other semiconductors, e.g., III-Vs, germanium (Ge), etc.

Patents

- Published Application: 20210359150
- Issued: 11,588,066 (USA)

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