1. Problem

- Global warming ♨️🌍🥵. Need to reduce CO_2 emissions
  - Increase clean (esp. solar) energy adoption ☀️🏘📈
  - Reduce the cost ☀️💵📉 (DOE's *Sunshot* program)
  - Increase power conversion efficiency. Decreases both hard and soft cost per Watt 🙌
  - Highly efficient, low cost tandem solar cells
    - However, so far unsuccessful
      - III-V solar cells efficient but too expensive
      - Perovskite cells efficient and cheap but still unstable
      - Need for new materials

How?

2. Solution

Novel Materials: 2D Transition Metal Dichalcogenides (TMDs)

- Ultra-high light absorption coefficients
  - Can be ultra-thin (<20 nm) and flexible
    - Also enables unprecedented applications in wearable and internet-of-things (IoT) electronics, architecture, transportation, aerospace and defense
- Desirable bandgap values (1.0-2.2 eV)
  - can achieve >40% in a 4-terminal tandem TMD-TMD (or TMD-Si) structure (based on detailed-balance calculations)
- Intrinsically passivated surfaces
  - No lattice matching required to form heterostructures

3. Challenges

- Conventional doping methods damage TMDs irreversibly
- Conventional contact metal deposition techniques results in poor, defective TMD/metal interfaces
- Conventional light trapping mechanisms are not as effective
- Immature growth methods

4. Our approach

Novel approaches. Record-breaking performance in single-junction TMD solar cells.

- Charge transfer doping using fab-friendly transition metal oxides
- Metal-Interlayer-Semiconductor (MIS) contacts
- Metasurface-based light trapping schemes
- Scalable growth method (sulfurization, selenization)

5. Team

- Koosha Nazif (PhD Candidate)
  - Expert in ultra-thin solar cells (efficiency records in ultra-thin Si and TMD cells)
- Dr. Alwin Daus (Postdoctoral Researcher)
  - Expert in flexible TMD electronics (synthesis, transfer and device fabrication)

- Electrical Eng. Dept, Stanford University