Polycrystalline Thin-Film Research: Cadmium Telluride

Scope. The CdTe Research Group develops processes and a range of materials for CdTe photovoltaic (PV) devices. This work includes advanced characterization, fundamental theory, and collaboration with university and industry partners. The objectives are to improve CdTe photovoltaic performance, reduce costs, and advance fundamental knowledge.

Core Competencies and Capabilities. NREL has a world-class assembly of CdTe PV research tools and expertise. The group works on both single-crystal materials for fundamental research, and polycrystalline devices that are industrially relevant in the near term.

Our specific capabilities are listed below:

- CdTe Layers
  - Close-spaced sublimation (CSS) on 1.5" x 1.5" or 3" x 3" substrate
  - Co-evaporation for CdZnTe and CdMgTe
  - Molecular-beam epitaxy (MBE) of CdTe and other II-VI compounds
- CdS Layers
  - Chemical-bath deposition (CBD)
  - Nanocrystalline CdS:O by sputtering
- $CdCl_2$ Treatments
  - Wet process ($CdCl_2$ + methanol or H_2O)
  - Dry process (close-spaced sublimation)
- Back Contacts
  - Wet process (chemical pre-treatments + HgTe -doped graphite)
  - Dry process (ion-beam treatment + ZnTe:Cu/Ti)
  - Alternative contact processes such as Cu/Au, CuTe, and SbTe
- Barrier Layers
  - SiO_2 by low-pressure chemical vapor deposition (LPCVD) and plasma-enhanced chemical vapor deposition (PECVD)
- TCO Layers
  - SnO_2:ZnO, CdO and related alloys by metal-organic LPCVD
  - In_2O_3, ZnO, Zn_2SnO_4, and Cd_2SnO_4 and related alloys by reactive sputtering
  - High-permittivity alloys
- Buffer Layers
  - SnO_2 by metal-organic chemical vapor deposition (MOCVD)
  - SnO_2, Zn_2SnO_4 alloys by sputtering
- Characterization throughout the NCPV includes
  - Lifetime, Hall, accelerated-lifetime-testing, current-voltage, DLTS, capacitance, SIMS, Auger, XPS, cathodoluminescence, photoluminescence, TEM, EBSD, XRD, and ICP measurements
- Collaborations with NREL computational scientists include
  - CdTe ab-initio density functional theory calculations, device simulation, and advanced measurement simulation

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