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Development of a Method to Characterize Microstructure and Electrical Performance of CdTe Arrays

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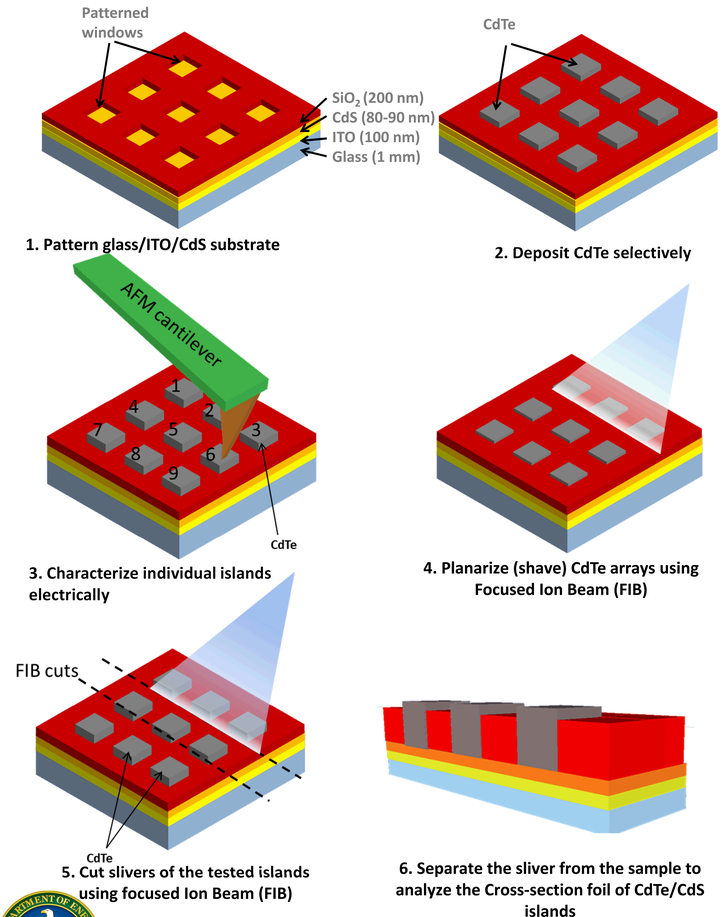
Motivation

Polycrystalline CdTe thin films are grown with defects that affect the electrical performance of solar cells. A characterization technique is needed to differentiate the beneficial from the detrimental effect. Open circuit voltages could be highly increased if detrimental defects are reduced.

Objective

- Develop a fabrication technique to isolate defects in CdTe solar cells.
- Develop a characterization method to make a one-to-one electrical–structural correlation in CdTe solar cells.

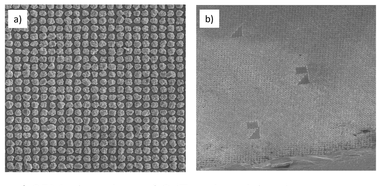
Method



Fabrication

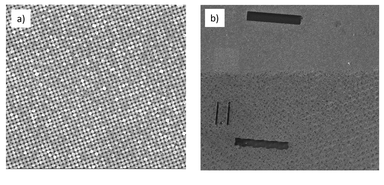
- 2 µm and 300 nm-feature size SiO_2 windows were fabricated on glass/ITO/CdS substrates.
- CdTe was deposited only inside each micro and nano SiO_2 window and nowhere else.
- Micro and nano-pn junctions were indexed, identified and prepared for EBSD and TEM

Micro-islands



a) SEM plan view of CdTe micro-islands deposited on glass/ITO/CdS/SiO_2 patterned substrates and b) FIB micro marks on substrate used to index and identify micro-islands.

Nano-islands

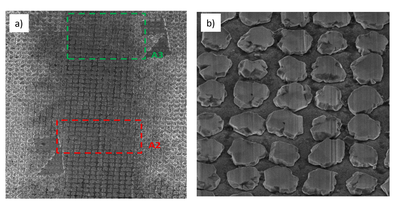


a) SEM plan view of CdTe nano-islands deposited on glass/ITO/CdS/SiO_2 patterned substrates and b) FIB micro and nano marks on substrate used to index and identify nano-islands.

Sample Preparation

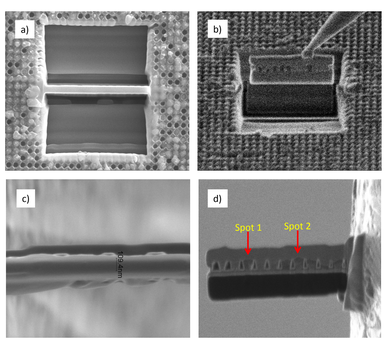
- Surface and cross-section of CdTe arrays were prepared for crystal orientation and defect studies
- The surface of CdTe micro-islands was shaved using a dual-beam SEM/FIB system for EBSD characterization
- Thin foils were prepared from CdTe nano-islands for TEM characterization.

Micro-islands



a) Low and b) high SEM magnification of a group of CdTe micro-islands after surface planarization. Red and green dashed rectangles show areas of interest for EBSD characterization.

Nano-islands

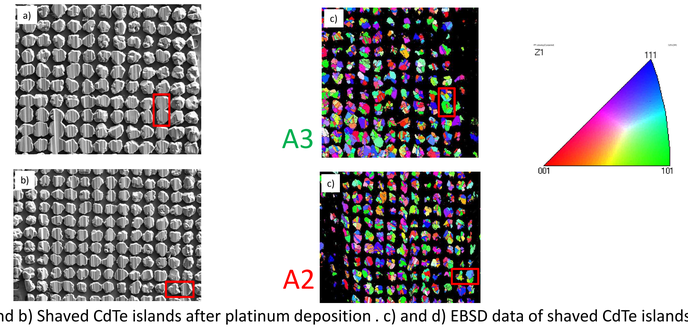


Sample preparation process for TEM showing a) plan view of initial trenches, b) omniprobe pulling foil out of the substrate, c) foil plan view after thinning and d) thin foil containing a row of CdTe nano-islands mounted on TEM grid.

Results

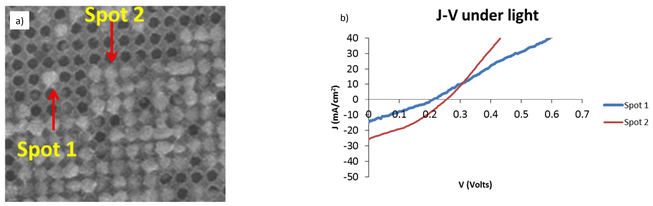
- Number of grains per island were obtained from EBSD.
- Grain orientation per island is known.
- CdTe islands were successfully indexed and identified.
- Nano-pn junctions were successfully tested under light bias.
- Nano-pn junctions convert light into electricity.

Microstructure

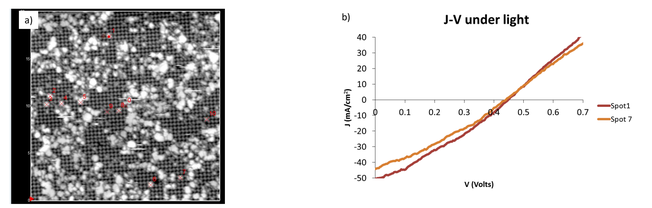


a) and b) Shaved CdTe islands after platinum deposition . c) and d) EBSD data of shaved CdTe islands.

Electrical



a) SEM plan view of two CdTe nano-islands where b) J-V measurements were performed under light conditions



a) AFM height image of CdTe nano-islands and b) J-V measurements were performed under light conditions

Conclusions

- Selective-area growth was used to isolate CdTe grains and test their atomic structure.
- EBSD was successfully performed and reveals crystallographic orientation.
- J-V measurements under light show operational nano-solar cells.

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