Influence of Grain Boundaries in Polycrystalline Silicon

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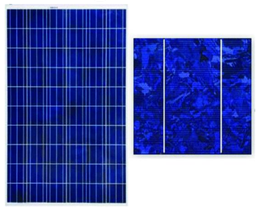
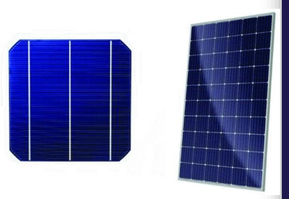
Introduction

- Poly-Si solar cells (SC) are cheap, simple, have little energy cost to produce
- Grain boundaries (GB) considered detrimental to poly-Si solar cells.
- GBs: high defect density, location of recombination
- Use of monocrystalline Si or other materials necessary for higher efficiency



Polycrystalline SC:
η ≈ 22 % (lab) [1]



Monocryst. SC:
η ≈ 25 % (lab) [1]

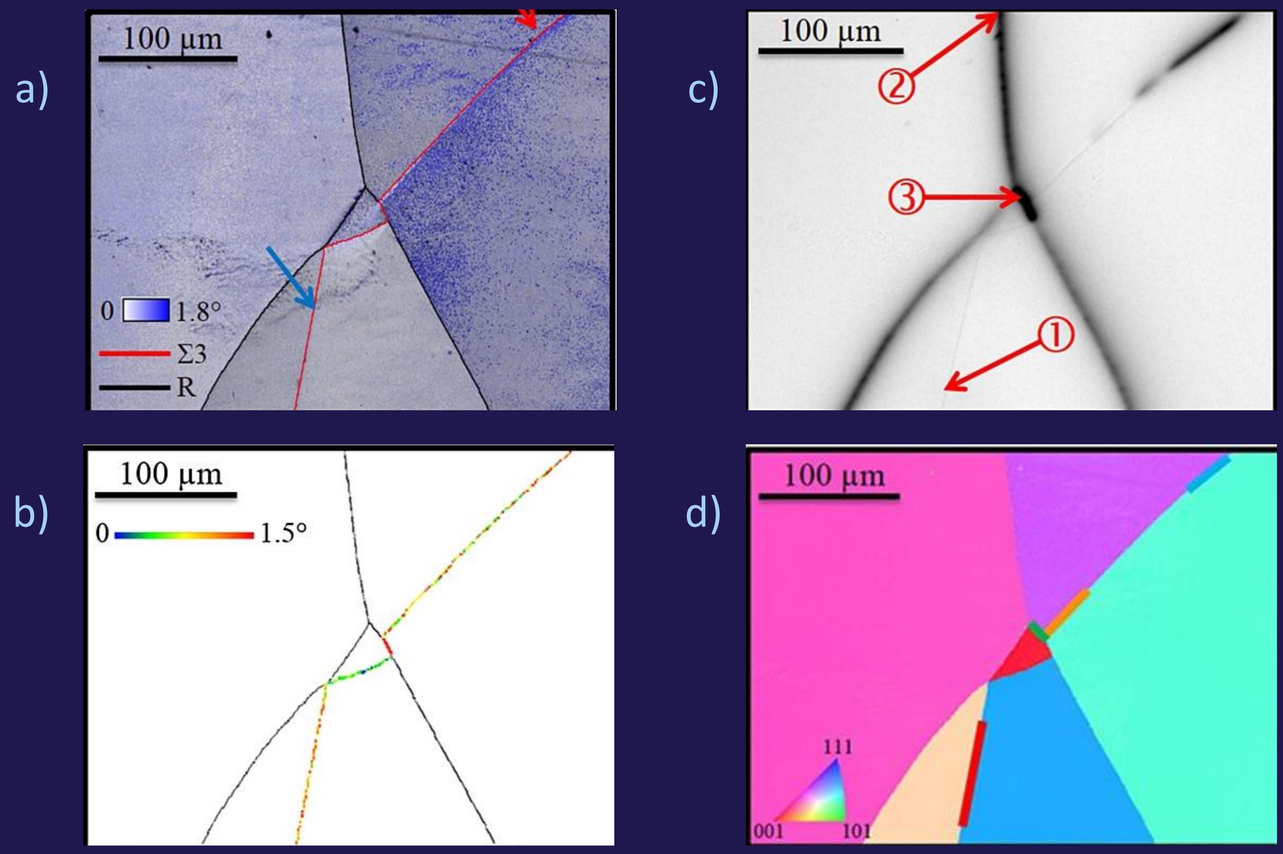
Methods

- Atom probe tomography (APT)
- Electron backscatter diffraction (EBSD)
- Electron-beam induced current mapping (EBIC)

Results

- Significant advances in understanding metal GBs [2].
- GBs can be beneficial, proven for $Cu(In,Ga)Se_2$ (CIGS) [3].

Grain boundaries in **poly-Si** are being investigated to increase solar cell **efficiency** and decrease **costs**.



(a) SEM image of multicrystalline Si sample overlaid with EBSD information on grain boundary crystallography. (b) GB map indicating the deviation from ideal Σ3 definition. (c) EBIC map of the studied sample area. (d) Inverse pole figure map of sample area with colored plane traces [4]. This type of investigation is to be replicated for polycrystalline Si.

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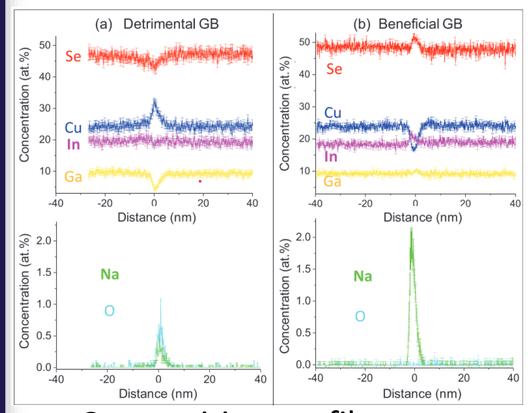
Discussion and Outlook

- Determination of influences on structural, chemical and functional GB properties
- Determination of what makes a Si GB beneficial
- Intentional transformation of GB properties to benefit SC efficiency

Additional info



- Composition profiles across a detrimental and a benign GB as extracted from APT measurements of CIGS [3].

Sources

[1] Mesquita, D. *et al.* 2019. IEEE PES ISGT Latin America. https://doi.org/10.1109/ISGT-LA.2019.889536

[2] Meiners, T. *et al.* (2020). *Nature* **579**, 375–378 https://doi.org/10.1038/s41586-020-2082-6

[3] Raghuwanshi, M. *et al.* (2020). Adv. Func. Materials, 30(31). https://doi.org/10.1002/adfm.202001046

[4] Stoffers, A. et al. (2015). *Prog. Photovolt: Res. Appl.*, 23: 1742–1753. https://doi.org/10.1002/pip.2614