Catalyzing Innovation in PV Manufacturing

An NSF Workshop

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Highlights and Summary of Facilitated Discussion

Session IV – Scaleup to TW/yr Production

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Dr. Eray Aydil, University of Minnesota

Materials Availability for TW Deployment

Materials Availability

- PV Materials: Te byproduct of Cu, In and Cd are byproduct of zinc
- Scarcity a function of assumptions: Estimates range from little concern to major concern
- Argues that the uncertainty it is worth exploring abundant, easily extracted materials

A Leading Candidate: CZTSS ($Cu_2ZnSnS_{4-x}Se_x$)

- Similar to CIGSS, in terms of crystal structure, band gap, device architecture, and process strategies.
- Produced by sulfurization of metals/alloys or through production of CZTS nanocrystals
- After limited study (<60 publications) the sulfur form is up to 6.8% efficiency, while selenium form pushing 10% (IBM). Justifies the attention paid to it.
- To date CIGS architecture employed (Mo/CZTS/CdS/TCO), little work has been done to explore alternatives.

Dr. Vasilis Fthenakis, Columbia University/Brookhaven National Laboratory

Life Cycle Analysis for PV

Energy Payback/Environmental Sustainability

- c-Si (1.5 years), CdTe (0.5 years) in high flux regions (SW US)
- PV has net energy ratios of (Energy Produced: Energy Consumed in Production) of the order of 20-40, tremendous numbers not only for renewables, but any energy source.
- Green house gas emissions 30-40X less than conventional fossil fuels

CdTe Manufacturing: Focus on Cd Emissions

- With recycling less emission per energy produced than burning coal or oil
- 57 companies engaged in voluntary recycling efforts
- Cd emission not a concern in accidents (i.e. either leaching due to a break or fire hazard)
- Cd byproduct of Zn production, which is not going away. The Cd byproduct must either used or abated. Argues that its use in PV the safest route to use/store Cd.

Dr. Peter Hacke, National Renewable Energy Laboratory
Research Opportunities in Reliability of Photovoltaic Modules

Motivation

- Reduce risks and costs, improved forecasting
- LCOE increases 10% per 1% increase in degradation rate
- Very little study of performance in the field, different environments
- Significant area of employment

Present Research Opportunities

- Module Materials: Understanding degradation of module materials: encapsulants, wires, connector
- Reliability Engineering: Mapping of failure mechanisms observed in the field to those obtained under accelerated lifetime testing, Clarifying the failure mechanisms
- Quantitative reliability models for PV need further development: Combined effects
- Inverter Degradation: Often much worse than module

Session IV: Scaleup to TW/yr Production – Panel Discussion

Comment #1: Questions of materials availability could dramatically change if rare elements (In, Te) were mined directly instead of relying on byproducts.

Comment #2: Good news about CZTS, has many attributes of CIGS. Drawback of CZTS, it has many attributes of CIGS.

Comment #3: Debated Point: Tradeoffs in investing in improving what is known to work as opposed to investing in new materials. Balance is key.