Path Forward in PV Research: News from BAPVC

Robert J. Davis, Ph.D.

Co-Director, Wright Center for Photovoltaics Innovation and Commercialization (PVIC), OSU Node
Director, Ohio State Nanotech West Laboratory
Associate Director, OSU Institute for Materials Research (IMR)

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Contents

- Recent major DoE SunShot Program Awards
- News from the Bay Area Photovoltaic Consortium (BAPVC)
- Pricing Pressure Trends in PV
- What is *affordable* solar durability?

*Right: Picosun SunALE R-150 atomic layer deposition tool at the Ohio State Nanotech West Lab, funded by PVIC (Ohio Third Frontier)*
Recent Major DoE SunShot Awards (2011)

- **Industry-Led Consortium, SEMATECH** – PVMC $62.5M / 5 years – CIGS pilot line and research, in partnership with SUNY Albany CNSE and UCF

- **PV Manufacturing Development Facility, SVTC** - $30.0M / 5 years – baseline cell fab flow available to industry users

- **Bay Area Photovoltaic Consortium** – Stanford/UC Berkeley - $25.0M / 5 years – will fund industry-steered research in PV at US universities on an open competitive basis
  
  - Web site should be up soon
  - First call for programs will appear soon
John Benner – Ohio State IMR Colloquium
06 March 2012

- “Made in the USA – Photovoltaic Energy Solutions”
- Full set of slides from his talk is available on the IMR web site under Events (www.imr.osu.edu)
- Many thanks to John for some of these slides which are used here
Challenges of the BAPVC Consortium

- How to address multiple, vastly different technologies – CIGS versus c-Si versus CdTe and CPV – approached at the moment by separation into absorber, contacts, substrate, packaging issues etc.
- How to attract and maintain industrial membership
- How to manage a two-node consortium – similar to U. Toledo and Ohio State in PVIC
- How to manage IP issues between institutions, DoE, industrial members, and externally funded research
Our Whole Module Approach to Reach $0.50/W Modules

Nanoscale photon management

Encapsulation
- Hygroscopic nanoparticle (Ammonium Sulfate)
- Hydrophobic Polymer with compatibilizing tail

Novel electrodes
- Metal nanowire transparent electrode

Substrates
- Nanocone substrate

500 nm

Absorber and junction
- Transparent electrode
- Antireflection electrode
- Bottom contact
- Substrate

Reliability
- Water, O₂, H₂, other active chemical species
- UV Exposure
- Cracking and delaminating
- Surface weathering
- Photochemical reactions
- Defect evolution in nanostructured layers

Advanced materials characterization

Energy [eV]

10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
10⁻²
10⁻¹
10⁰
10¹
10²

Wright Center for Photovoltaics Innovation and Commercialization
PV Learning Curve ($2010)
Projected vs Realized

- Actual
- Historical
- Projected

1979 $33.44/W

Cumulative Production (MW)
Module Price ($/W) ($2010)

Wire saws
First Solar
Wafer thickness 300
Wafer thickness 200
Wafer thickness 150

2010 $1.81/W
2010 $2.20/W

R. Swanson, IEEE PV Specialists Conf., June 2011
US PV Manufacturing

- Bad news: US PV module shipments are flat while world markets have been growing rapidly
- Good news: US still supplies ~25% of the total world supply chain

<table>
<thead>
<tr>
<th>PV Supply Chain</th>
<th>2010 Sales ($B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Poly Silicon (exported)</td>
<td>2.5</td>
</tr>
<tr>
<td>Encapsulation -- Glass, EVA, Backsheet</td>
<td>~2</td>
</tr>
<tr>
<td>PV Equipment</td>
<td>1.4</td>
</tr>
<tr>
<td>PV Modules</td>
<td>1.6</td>
</tr>
<tr>
<td>U.S. % of Global PV Product Sales</td>
<td>~25%</td>
</tr>
</tbody>
</table>

Source data: Paula Mints, Principal Analyst, Navigant
Cost Projections

$1/Watt


Note: Change to legend from previous slide.

Residential Payback

- < 5 years
- 5 - 10 years
- 10 - 20 years
- > 20 years

Principal Analyst:
Sean Ong, NREL SEAC
What Solar Durability is Affordable? Or Best-Suited for Widespread PV?

- Disclaimer: the author is not very well-versed in economics, business, tax issues, nor reliability
- If PV will hit $1/Wp as it appears it will, how long will those panels need to last to be attractive to customers?
- Is the “25 year” durability target for PV an outdated cost model?
- The recent First Solar issues need to be mentioned here
- Also note: although typical industry ROI targets are ~7 years, typical energy savings project targets are evaluated at ~3 years (per Mark Schuetz, Replex Plastics)