U.S. PV Manufacturing and Opportunities for Florida

Winston V. Schoenfeld
Director, PVMC-FL
Associate Professor
Florida Solar Energy Center & CREOL
University of Central Florida
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SE – Selective Emitter
Selective Emitter Process
The inline system for producing selective emitters with the aid of inkjet printing technologies is integrated into the Single Side Edge Isolation and PSG equipment.

Basic concept of the Selective Emitter
With this combined printing and etching technology, the high phosphorous doping layer is selectively etched on to the cell and only maintained in those places where contacts are subsequently printed. For this purpose a wax mask is applied in inkjet printing. The utilisation concept of the selective emitter increases the efficiency of the solar cell by up to 0.8%.

Reduction of the doping concentration for the active emitter area
Higher doping concentration underneath the fingers and bus bars compared to the optical active cell area

The DoD Inkjet Printer is required in combination with the SE-process for digital printing of the etch masks.

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Manufacturing Share of Gross Domestic Product

- U.S.: 11.7%  China: 25%
- By Comparison it was 28% in U.S. in 1950’s

Note: Not due to reduced manufacturing, but rather slower growth rate.

Why care? General estimates are that every new manufacturing job generates 5 other jobs in the economy.
Manufacturing is not just Cells/Modules

Note: U.S. had $247M trading surplus with China

Market Share

40%

3%

4.6%

3%
Government Support of PV Manufacturing (loan guarantees)

- **U.S. - Section 1705 of the 2005 Energy Policy Act**
  - $15.6B in loans ($10.5B for solar), but ~$1B in 2010

- **China - China Development Bank (CDB)**
  - $30B in 2010 loans

Data from Grist.org and Greentech Solar
Is there another way to maintain/grow U.S. PV market share?

- Government Loan Guarantees are not enough
  - Need Multiple support structures
    - Capital costs
    - Bankability (finance)
    - Strong/talented work force
    - Proximity to innovation
- Loan Guarantees address first item

- Is there another *complimentary* route for U.S. PV market share growth?
Can technical innovation drive U.S. market share?

**Question:** Why has Intel has led IC industry for 19 years?

**Answer:** 3-7 years Transistor technology lead – 50-100% pricing power.

**"Transistor Design" Advantage**

- SEMATECH Led Industry to ALD HfO$_2$ as High-k – Intel adopted novel integration
- IMPACT: Intel’s competitive edge results in ~ $100B revenue from high-k HfO$_2$
My experience - A snapshot of the LED industry

- In 2000, there were many U.S. LED companies
- Common price of blue LED chip $0.20 - $0.30
- Two years later price was $0.05 - $0.10

- **Cause**: Despite rapid market growth, Asian manufacturing (i.e. supply) grew faster.
- **Result**: Only handful of major LED U.S. manufacturers remain.

- **Common Denominator**: All invested in technical innovation, allowing them to stay ahead of commodity curve.
Some History from Semiconductor Industry

“The most significant finding of the Task Force is that U.S. technology leadership in semiconductor manufacturing is rapidly eroding and that this has serious implications for the nation’s economy and immediate and predictable consequences for the Defense Department.”

- Defense Science Board Task Force on “Semiconductor Dependency” - February 1987
U.S. Photovoltaic Manufacturing Consortium (PVMC)

- DOE decided it needed a similar SEMATECH model for the PV Industry
- Led by SEMATECH in partnership with CNSE (College of Nanoscale Science and Engineering) and UCF (University of Central Florida)
- Overall investment of ~$300M over 5 years from DOE and matching funds
- Initial focus on CIGS and cSi technology and manufacturing solutions
## What the U.S. PVMC Provides

### The challenge

- Industry alignment
- Lack of infrastructure
- Lack of place to work
- Metrology, test and reliability
- Manufacturing cost – CIGS and cSi
- Balance of system, technology commercialization, workforce development
- Cost of PV energy to consumer

### The PVMC solution

- Roadmap and standards
- Collaborate to fund and create it
- Advanced manufacturing development facility
- Develop, model, and share capabilities
- Improved methods = reduced cost
- Support to the industry
- Consortium = shared knowledge and resources and reduced cost of manufacturing = reduced cost to consumer
Key: Establishing **Collaborative** Consortia

- PV Industry is historically fragmented
- How do you get consortium members – even direct competitors – to work together?

Consortium Program

Distributes Risk & Cost

Accelerates Progress