The way to make amorphous and application

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What is AMORPHOUS?

- Named because of their composition at the microscopic scale
- Non-crystalline solid(without shape)
- Lacks the long-range order characteristic of a crystal
- Small, disorderly variation in the angles between the bonds eliminates regular lattice structure
- Nowadays refer to GLASS,PLASTIC and GEL

What is an amorphous solar cell

- The cell is not highly structured or crystalized
- Created by applying doped silicon material to the back of a plate of glass
- Appear dark brown on the sun-facing side and silvery on the conductive side.
- When it is used as a solar panel, it will appear to have several thin parallel lines across its surface
- Those lines break in the N and P layers of the silicon substrate and the boundaries of individual cells in the panel

Hydrogenated Amorphous Silicon

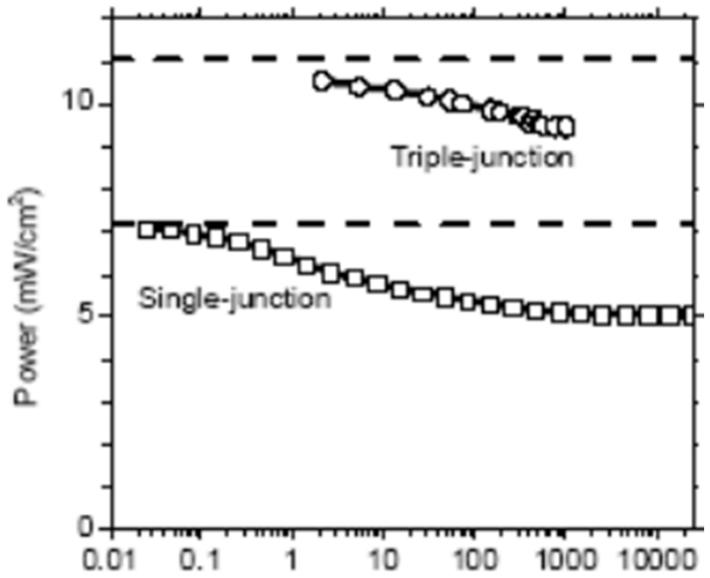
- Another name is amorphous silicon or a-Si:H
- Technology is relatively simple and inexpensive
- A-Si:H absorbs much more energy than c-Si(single crystal) in same layer thickness(about 2.5times)
- Can be deposited on a wide range of substrates, including flexible, curved, and roll-away types
- Much less material required compare to c-Si

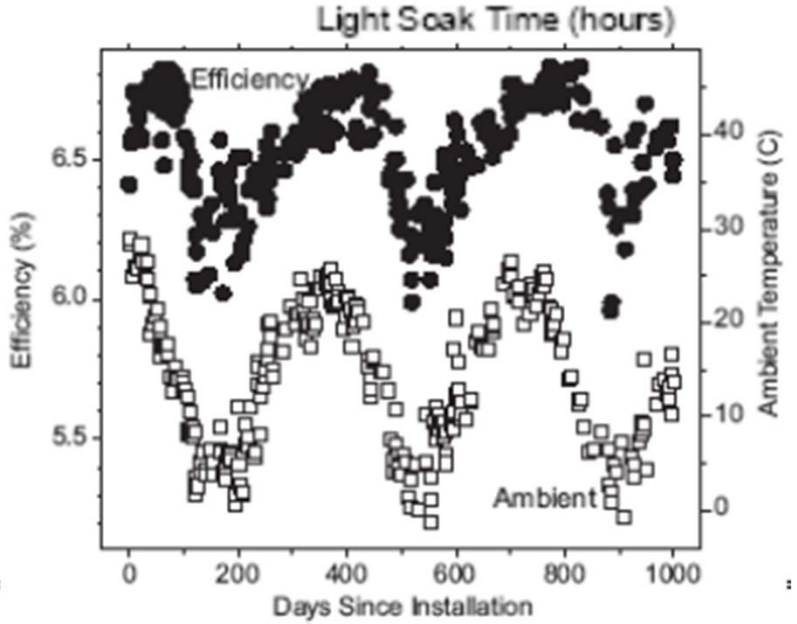
Atomic Structure

- several percent of silicon atoms make covalent bonds with only 3 neighboring silicon atoms, the remaining electron bonds with a hydrogen atom
- The D-center, or dangling silicon bond, is the most influential defect on electronic properties
- The defect density has been shown to increase, then stabilize, with increasing illumination time, or “light soaking’
- It is called Staebler-Wronski Effect. Performance degrades because of the increases of defect density

Staebler-Wronski Effect

- A-Si:H modules reach steady-state after about 1,000 hours of steady illumination(so that is 80% performance compare to the new one!)
- Seasonal variations in conversion efficiency were noticed.





Staebler Wronski (cont.)

- Fluorine bonds tighter to silicon than hydrogen, and is less mobile in the a-Si network
- Fluorinated a-Si cells show much better stability under light soaking

Doping a-Si:H

- Most dopant atoms do not contribute a free electron and do not raise the Fermi energy level because a negatively charged dangling bond is also created.
- For each dopant that does contribute an electron, there is a balancing SI dangling bond to receive it.
- Therefore, it is very hard to increase the efficiency of a-Si:H by doping.

Alloying with Additional Elements

- Alloying with elements, such as Ge, can be accomplished during film production
- The resulting alloys have wide ranges of bandgaps
- This can be very useful for creating multijunction pin cells, where the narrow bandgap of a-SiGe allows for increased absorption of lower energy photons

Large-Scale Production

- Not because of the efficiency but the cost
- Roll to roll manufacturing processes are used
- Four continuous processes:
  - Substrate washing
  - Sputter deposition of back-reflector
  - a-Si semiconductor deposition
  - ITO top electrode deposition
- Large roll can be cut into different sizes to meet application needs

Application

- A-Si has been used as a photovoltaic solar cell material for devices which require very little power such as calculator (1% efficiency)
- According to the National Renewable Laboratory (NREL)First Solar, the best research-cell efficiency is 13.4% and the best solar module efficiency is 8.1%.
- Low power output of amorphous silicon solar cells limited their use to small application only.
- It also powers some private homes, building, and remote facilities.
- The market leader are Sharp and Sanyo.

Future of amorphous silicon solar panels

- In 2011, amorphous silicon solar cells represented about 3% of market
- Sharp retired 160 out of their 320 MW production capacity in Japan earlier this year
- Optisolar, Signet Solar, Unisolar, and many other companies that were touting the amorphous technology are acquired, bankrupt or closed.
- So the future of larger-scale amorphous silicon solar panels does not look very bright

Reference

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