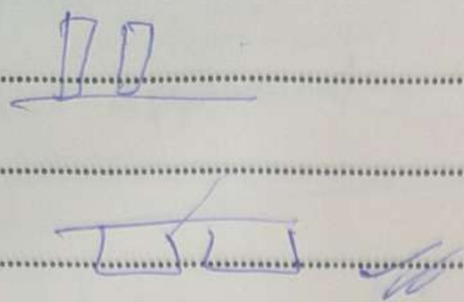
solar
cells



cw

Keywords

① Solar Photovoltaic energy

② c – si solar cell → single crystalline
Solar cell

③ Thin film solar cells → substrates →
glass, stainless
steel
Plastic foils

④ Currently 3rd generation
of solar cells → heterojunction,
hybrid, multijunction,
perovskite &
organic solar
cells

⑤ a – SiH Hydrogenated amorphous silicon.
μc – SiH → Hydrogenated microcrystalline
silicon
for thin film solar cells
due to good optoelectronic properties

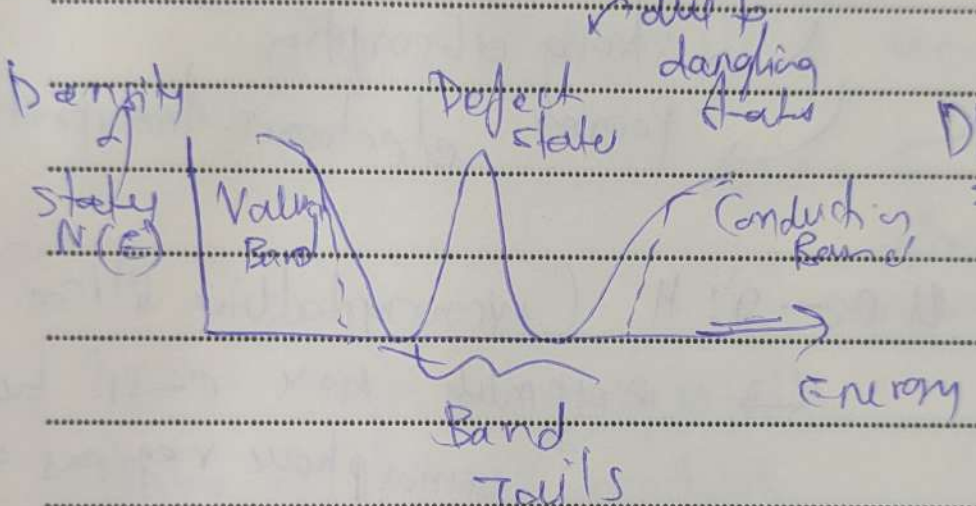
shape

Note evolution of H necessary
$SiH_3 \rightarrow Si$ as well as H both bond with Si
deposit → the Si bond ~~has to break~~ bond with H

How to make a-SiH → add Hydrogen to
~~during deposition~~

deposition a-Si:H using Silane($SiH_4$)
as a precursor gas

Silane plasma → 80% gas radicals
are $SiH_3$




Dbt pg 5
last para.

a Si-H thin films → PECDV as well
as HWCVD
hot wire.

µc-SiH → binary phase material
heterogeneous material
in which crystaline Si phase is
embedded in amorphous silicon
matrix.
high µ & σ as compared
to a-SiH

Note (PECI)

a Si:H (amorphous silicon)

→ High defect density
→ strong absorption
→ Poorer electronic transport.

μc-Si:H (microcrystalline silicon).
→ Resemble more c-Si but amorphous regions also present
→ Fewer defect
→ Better carrier transport but relatively weaker absorption than a-Si:H

Note:
a-Si:H absorbs mostly visible light (≈ 400–800 nm)

Note:- μc-Si:H → extends absorption to near IR (≈ upto 1100 nm)

Tandem solar cells
Top cell → a-Si:H (visible)
Bottom cell → μc-Si:H (near IR)
cooperate.

shape

Note :- PECVD → Dont require High temp
Just generate plasma somehow → high field perhaps!!

* Silicon Thin films solar cells based on a-SiH & Mc-SiH

doped → p-i-n structure
intrinsic sandwiched b/w p & n type silicon

Intro of dopant into a-SiH or μ-SiH → high dangling bonding in films

dangling bonds → acts as charge traps!!
defect state, & recombination centers.

So even if sunlight generates e⁻ & holes → they recombine quickly & dont reach external circuit
→ low photocurrent.

Note

Simple PN junctions fails in Thin films.

↓ soln

introduce an intrinsic (i) layer

p-layer | i-layer | n-layer

↑ Act as main absorber layer (No recombin$^n$ due to dopants)

Note:- Thin film solar cells work on drift-based charge transport.

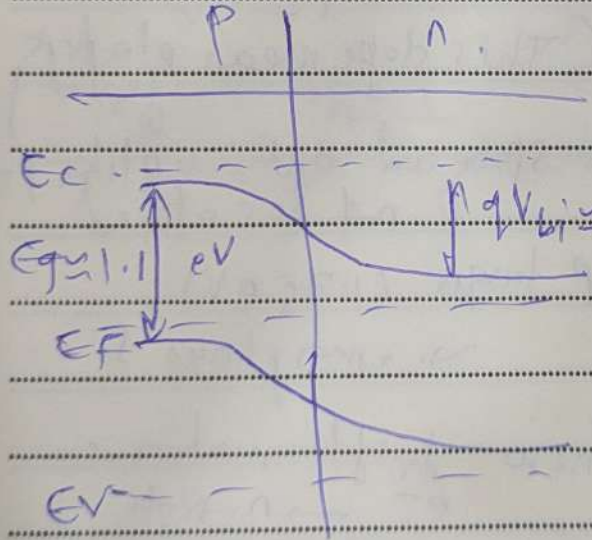
Thicker i-layer → more absorption but if too thick → weaker field → recombination ∴ Has to be optimized

(carriers move due to field, not due to conc gradient) that extends uniformly across entire i-layer.

Note:- Photon enters cell → absorbed in i-layer → generates an $e^-$ hole pair → Built in 'E' → displace $e^-$ n-side & pushes hole p side → charge reaches contact → current flow.

Note:-

| | p-n (c-Si) | p-i-n (thin film) |
| --- | --- | --- |
| Transport | Diffusion | drift |
| Diffusion length | ~100 μm. | ~1 μm. |
| main Absorber | Bulk | i-layer |
| Defects | Low | High |




⟹ Note

Ec & Ev bend only at interface very narrow region.

implies ⟹ e-field exists only near the junction.

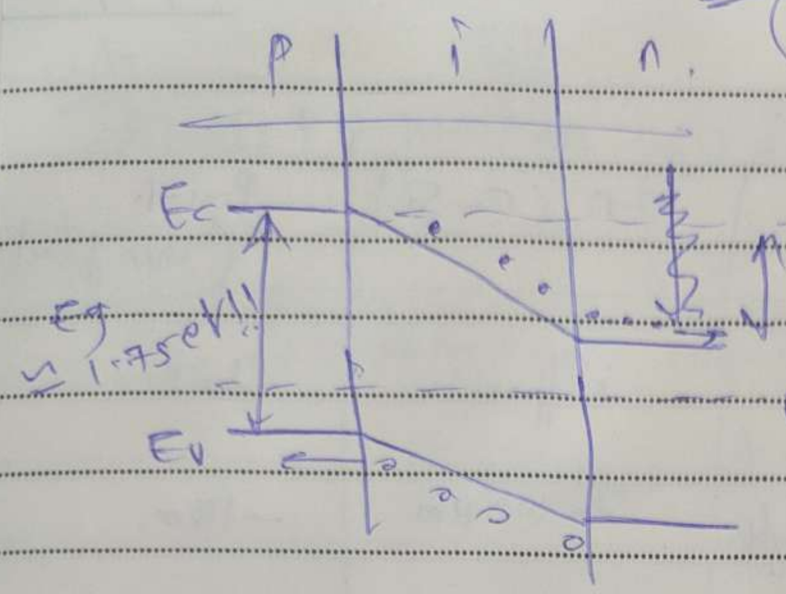
* eval'n of $V_{bi}$ in a c-Si p-n type diode.

Key: Diffusion    E.F = narrow

Key

Drift

EF → middle




⇒ evolⁿ of $V_{bi}$ in an a-Si p-i-n diode.

⇒ Note

* Ec & Ev slopes across the entire i_layer

(This slope mean electric field)

* field is spread out unlike p-n & not localized

* Bandgap larger (1.75 eV)
→ amorphous Si

* arrow show drift motion.
$e^-$ → n-side
holes → p-side

drifting
No diffusion struggle

Field forces them apart immediately

extra micromorph solar cell read
single junction μc-si thin film solar cell - read
tandem cell !

objective :-
Fabricate a-Si:H / μc-Si:H
at low temp
using HWCVD.

HWCVD better than PECVD -
- device quality better at low temp.
- prevents bombardment effect
- better utiliz^n of precursor gases in HWCVD.
- lower ownership cost.

Task / Object
wanted to do at low temp
→ might lead to standard defect
∴ approch → hydrogen dilution in silane.

II object - fabricating thin films on a low cost flexible substrate.

method
object 3 improve deposit^n rate of μc-Si:H thin films by HWCVD without compromising device quality
from 0.5 nm/s to 0.1 nm/s

Shape