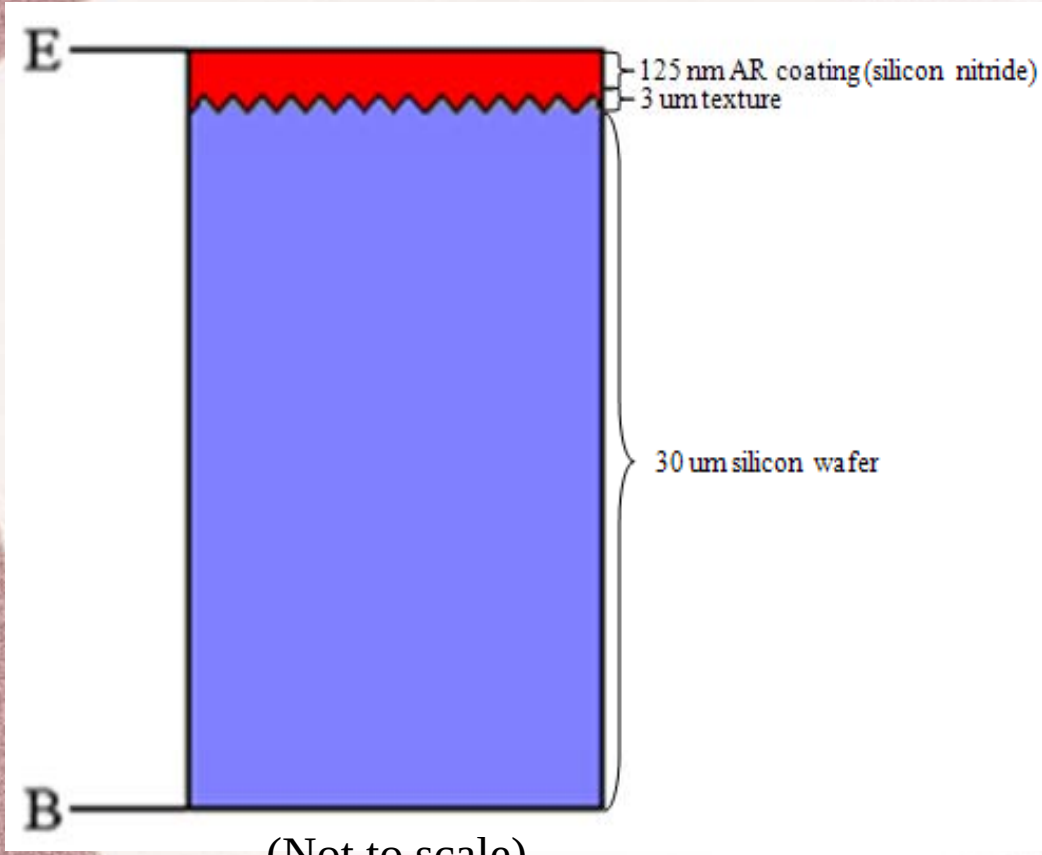
Silicon Solar Cell Design and Manufacturing Plan

Student B

Team SoloLoco

Device Schematic



(Not to scale)

- Surface area = 100 cm^2
- Texture = .1(thickness)
- Doping: 1x10^16 cm^-3
- ARC thickness = (500 nm)/4
- ARC refractive index = $(n_1 n_2)^{.5} = 2$
- Efficiency = 15.21%

PC1D Simulator and Assumptions Made

- Most parameters remain at their default value
- Texture, AR coating added
- Thickness reduced to 30 um – “thick film”
- First front diffusion doping changed to 1x10^19 cm^-3 peak to make p-n junction
- Excitation from ONE-SUN averages incident power from the sun on a clear day
- Limited by DC current flow from solar panels
- Limited by lack of energy storage technique/device

Tradeoffs

- Film thickness vs. lifetime
  - Lifetime – lifetime of individual carrier when struck by sun
  - Carrier diffusion length – average distance carrier travels in its lifetime
  - Carrier diffusion length = (carrier diffusivity * lifetime)^1/2
  - Carrier diffusion length must be greater than thickness of cell
  - Thicker cells (i.e. wafers) run the risk of not being useful if thickness > carrier diffusion length
- Cost
  - Wafers vs. thick films vs. thin films
  - Thin films are most costly to manufacture but fare better in original tradeoff

Manufacturing Processes

1. Silicon extracted and purified
2. Silicon is p-type doped (background doping)
3. Texturing added
4. N-type doping added to make p-n junction
5. Anti-reflective coating added
6. Metal contacts added to “collect” current
7. Final cell assembled

- Cell is tested and purified multiple times throughout this process
- Manufacturing costs are the thing that most affects difference in price between different kinds of cells
- Manufacturing process will originally rely on fossil fuels but will eventually rely completely on solar power

Projected Capability of Production and Recommendations

- Solar cell factories can be operational within 18 months of project approval and run at full capacity after another year
- A mature 430 MW solar cell factory produces about 200 million cells/year and creates about 300 jobs
- We must implement manufacturing process slowly to allow for improvements in technology and increased support of project
- We must invest in research for converting DC current to AC and for solar energy storage techniques
- In the meantime, we must invest in DC household appliances

3.003 Principles of Engineering Practice

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