

# Detailed description of technology engineering essay

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Detailed description of technology

## **Solar Cell structure**

The solar cell is the basic building block of Photovoltaic technology , They are manufactured from semiconductor material the majority consists of wafer based silicone. An important property of a semiconductor material is that there conductivity can be modified by introducing impurities this process is called doping. This property is very useful in the fabrication of the solar cell. It allows for the creation of a Positive (P) and Negative (N) junction within the silicon wafer for current to flow in one direction. The basic structure of a silicon solar cell is as shown in fig and described below. <http://www.specmat.com/photovoltaic%20cell.png?keywords=photovoltaic+cell,makeup,solar+cell,photovoltaic,solar,cell,antireflective+layer,back+contacts&title=photovoltaic+cell&description=describes+how+a+solar+cell+works>

### **<http://www.specmat.com/solar%20cell%20specmat.html>**

A. Encapsulate: The encapsulate provides protection from the environment, it seals the cell. It made of a clear material such as glass or plastic. B. Contact Grid: The contact grid serves as a collector of electrons it is made of a good conductor material. C. Anti reflecting coating: This layer guides sunlight into the cell rather than having it bounce off the surface, it requires a good refractive indexD. N- Type silicone: This is created by doping the silicone with compounds (Phosphorous or Arsenic) that contain one more valence electrons than the silicone. This gives an available electron for conductionE. P- Type Silicone; This is created by doping the silicone with

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compounds containing one less valence electrons than the silicon (Boron). This makes for the existence of an incomplete bond (hole) this attracts electron from a nearby atoms to fill the hole thereby creating another hole. This movement of holes is available for conduction. F. Back Contact: This covers the entire rear of the solar cell acting as a conductor usually made from metal. How it works A photon of light which energy is proportional to the wavelength of light is channelled by the antireflective layer into the lower layers of the PV cell. A photon with greater energy than the silicon band gap will excite an electron from the valence band into the conduction band leaving behind a hole. Greenhouse Gas Emissions Total life cycle GHG emissions from solar PV systems are similar to other renewables and nuclear energy, and much lower than coal. <http://www.nrel.gov/docs/fy13osti/56487.pdf> Summary of existing products

## **Review of photovoltaic technologies**

Photovoltaic technology relates to the capturing of direct solar energy and its conversion to electricity; sometimes called a solar cell they offer a limitless and environmentally friendly source of electricity. It is subdivided into crystalline, thin film, compound semiconductor and nanotechnology. Solar cells are classified into three generations indicating the order of which each became important. First generation cells consist of the established Silicon based cells which are highly represented in commercial production. The second generation are the non silicon based thin film cells and the third generation involves new concept devices. All three generations are continually being researched for improving efficiencies, longevity and reducing costs. The following C: UsersebyrneDesktop2013-02-22\_1458. <https://assignbuster.com/detailed-description-of-technology-engineering-essay/>

All technologies related to capturing solar energy for a direct electricity generator are described as photovoltaic. However this technology is subdivided into crystalline, thin film, compound semiconductor and nanotechnology.

## **Silicone Crystalline Structure.**

These are the first generation of PV technologies which use silicon to produce solar cells and is the most popular having about 80-90 % of market share (solarbuzz) These cells (which consist of sections of semiconductors sandwiched between glass panels) are combined in modules to form PV panels. Solar cells can be connected in parallel and in series in order to achieve the desired voltage and current levels. These exhibit lifetimes of 20-30 years. Although silicone is a relatively poor absorber of light, its advantages is that it uses existing process technology of the microelectronics industry, and produces a stable solar cell with efficiencies of the region of 16 %. There are three types of cells under the umbrella of silicone crystalline structures, these are Mono-crystalline, poly-crystalline, and emitter wrap through (EWT)

## **Mono-crystalline PV**

This technology uses crystalline silicone p-n junctions. A mono-crystalline cell is a 0.3 mm thick wafer of Silicon; this is sliced from a high purity single crystal ingot which was cultivated using a process of crystal growth called the Czochralski method. The maximum efficiency is in the order of 23 %. This type is most efficient but is not cost effective per kWh.

## **Poly- crystalline PV**

This cell is less efficient at approximately 15% over the Mono crystalline cell but their manufacturing costs are lower. They are manufactured by melting silicon and solidifying it to orient crystals in a fixed direction producing rectangular ingots of multi crystalline silicon; these ingots are sliced in to blocks and then into wafers to produce PV cells.

## **Emitter wrap-through cells**

These cells have increased their efficiency through improved cell design. Small laser holes are used to connect n type contact with the opposite side emitter. As there is no front contacts it allows the complete front surface area of the cell to observe solar radiation. Renewable and Sustainable Energy Reviews Volume 15, Issue 5 2011 2165 - 2175

## **Thin film technology**

Thin film is a second generation PV technology; it has the potential of reducing the cost of PV by lowering both the material and manufacturing costs. Thin film panels are created by depositing thin layers of semiconductor material onto a substrate (Glass or Stainless Steel). The layer thickness is very small (~10 microns) compared to the crystalline wafer thickness (200-300 Microns) thus reducing the material costs. Using high throughput deposition processes, allows for reduction in manufacturing costs. The efficiency is lower than crystalline because their layers are much thinner, resulting in less absorption of the incoming solar radiation. The efficiency gap is decreasing by the ability to deposit different materials and alloys. There are four types of thin film cells; these are The Amorphous

silicon cell (multiple junction structure) thin poly-crystalline silicon on a low cost substrate, Copper indium diselenide/cadmium sulphide hetero-junction cell, and the cadmium telluride/cadmium sulphide hetro junction cell.

## **Amorphous Silicon**

Amorphous Silicon technology differs from crystalline silicone in that its silicon atoms are randomly located from each other. This randomness in the atomic structure gives the material a higher band gap in the region of 1.7 eV than crystalline silicone with 1.1 eV. This larger band gap allows the Amorphous Silicone cells to absorb the visible part of the solar spectrum more strongly than the infrared portion of the spectrum. Their substrates can be glass or stainless steel. There are a number of types i. e. double and triple junctions, tandem junction; each with their particular performance with efficiencies varying from 4 to 9 %. A problem with amorphous silicon technology is that they are affected by different operating conditions; causing cell degradation and conversion efficiency loss.

## **Cadmium telluride or cadmium sulphide/cadmium telluride.**

Cadmium telluride (CdTe) is a promising photovoltaic material having an ideal band-gap at 1.45 eV with a high absorption coefficient. Module efficiency of 9% have been demonstrated [23]. It is suitable for large scale production as it is easy to deposit making it competitive within the thin film domain. A disadvantage of CdTe is in the toxicity of Cd raising environmental issues and its use outdoors.

## **Copper indium selenide (CIS) or copper indium galliumdiselenide(CIGS)**

CIS has a high optical absorption coefficient and good electrical characteristics. These photovoltaic devices contain several elements from group 1, 3 and 6 in the periodic table; this gives high optical absorption coefficients and versatile optical and electrical characteristics enabling device tuning. Selenide increases the conversion efficiency by reducing the number of recombination sites. CIGS are multi layers thin film composites best described by the complex hetro-junction model. Module Efficiencies of 13% have been achieved [27]. It can be deposited by Sputtering, ink printing and electroplating; substrates can be glass or Stainless steel. A potential problem for the future is a possible shortage of indium which is used in idium tin oxide for flat screen displays.

## **Organic PV**

Organic solar cells are built from thin films of organic semiconductors consisting of a donor material and acceptor material. They can be constructed in a number of ways; bulk hetrojunction cells being the most favored configuration. Bulk heterojunction has interpenetrating donor and acceptor materials which provides shorter distance for excitons to travel to dissociation site for to contribute to charge generation. Efficiencies in the region of 5% are achieved to date. Despite this low efficiency inorganic photovoltaic is evaluated as one of the futures key technologies. The key property which " makes organic photovoltaic so attractive is the potential of reel to reel processing on low cost substrates with standard coating and printing processes".(Brabec, 2004) This makes for mass production

processes, compared to that of the heavy investment into semiconductor processing technology required for inorganic photovoltaic cells. The advantages of this technology is in it flexibility and disposability.

## **Nanotechnology**

Nano scale components to control the energy band-gap will improve the limitations of other PV technologies. To improve conversion efficiencies nanotechnology products such as nanotubes, quantum dots which can absorb more sunlight . [http://www. freepatentsonline. com/article/Science-Progress/219830600. html](http://www.freepatentsonline.com/article/Science-Progress/219830600.html)Gives good information of photo voltaic Practical guide to selection of appropriate technology for a local location Calculations with existing products in a specific local location Future research <http://energy. Itgovernors. com/investing-in-solar-electricity-whats-the-payback. html>

## **Structure**

Abstract Declaration Achnowledgements, TOC, LOF, IOT Introduction Literature Review Modelling, Results Analysis Discussion Conclusion