A

Seminar Report

On

**LABORATORY EXPERIMENT ON SOLAR PANEL USING DICHROIC PRISM**

*Submitted in partial fulfillment of*

*the requirements for the degree of*

Bachelor of Engineering

In Electrical (Electronics & Power )

of

Sant Gadge Baba Amravati University, Amravati

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Certificate

The seminar report entitled **“LABORATORY EXPERIMENT ON SOLAR PANEL USING DICHROIC PRISM**” is hereby approved as a creditable study carried out and presented by **Mr. Nikhil V Dhakade** in a manner satisfactory to warrant its acceptance as a pre-requisite in a partial fulfillment the requirements for degree of **Bachelor of Engineering in Electrical ( Electronics & Power)** of Sant Gadge Baba Amravati University, Amravati.

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[Electrical Engineering]

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Place: SSGMCE, Shegaon Mr. Nikhil Vijay Dhakade

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**Abstract:**

The Very High Efficiency Solar Cell (VHESC) program is developing integrated optical system - PV modules for portable applications that operate at greater than 30 percent efficiency. We are integrating the optical design with the solar cell design, and have entered previously unoccupied design space. Our approach is driven by proven quantitative models for the solar cell design, the optical design and the integration of these designs. Optical systems efficiency with an optical efficiency of 32% thus obtain using dichroic prism which use light to split into their component.

**Introduction:**

Today, most electronic equipment requires access to a source of power such as electrical wall outlets or batteries that can weigh as much or more than the equipment itself. The equipment may be used where electrical outlets are unavailable. In some instances, battery packs may be recharged but again this requires an electrical wall outlet or other power source. Further, battery packs may typically only be used for a very limited time before they need to be recharged again.

As the need for alternative energy sources increases, increasingly efficient solar power systems are being developed. Known solar cell systems typically concentrate the sun's rays and often require sophisticated tracking optics to consistently capture the most intense sunlight. Solar systems capable of providing enough power to operate many devices are often bulky and heavy and thus are not practical for use in portable devices.

Photovoltaic electricity costs are becoming more and more competitive. A stronger effort towards further development and technological innovation will make the sector more productive and competitive, and accelerate its evolution. As a result, the whole community will benefit from the increasing possibility that photovoltaic energy will be able to contribute substantially to EU electricity generation by 2020.

Amorphous silicon (a-Si) thin-film solar cells are one of the major candidates for flexible space solar cells, since it is known they have not only good radiation tolerance but many distinct advantages as well: high specific power, high flexibility, ruggedness, and tight rollup feature for storage. Additionally, they also have the potential for reductions of both cost and storage volume. Recently, the specific power of 1200 W/kg has been attained by triple-junction (TJ) solar cell and using dichroic prism the efficiency can be increase to 32%.

A significant portion of cost for multi-junction cells comes from the difficult fabrication involving the layered growth of several materials with different lattice constants. Strain and interface defects reduce the yield and overall performance of the cell. Solar splitting can also be achieved using dichroic mirrors which appear transparent for certain wavelengths and reflective at others. Designing dichroics into the already required concentrator incorporates various single-junction PV cells of differing materials instead of complicated, multi-junction cells. The proposed optic has the unique ability of using two dichroic reflections to provide 10x concentration onto interleaved PV cells placed on a common circuit board. The structure is cascaded into an array aiding in packaging and thermal management.

In addition, photovoltaics is already associated with a fast-growing and dynamic industry. This success story has been driven both by national support schemes and first-class research and demonstrat-ion. The European Commission strongly supports the development of the photovoltaic sector in its policy measures, and also in its research and demonstration activities.

**Solar cell:**

A solar panelis a device that collects photons of sunlight, which are very small packets of electromagnetic radiation energy, and converts them into electrical current that can be used to power electrical loads. Using solar panels is a very practical way to produce electricity for many applications. The obvious would have to be off-grid living. Living off-grid means living in a location that is not serviced by the main electric utility grid. Remote homes and cabins benefit nicely from solar power systems. No longer is it necessary to pay huge fees for the installation of electric utility poles and cabling from the nearest main grid access point.

A solar electric system is potentially less expensive and can provide power for upwards of three decades if properly maintained. Besides the fact that solar panels make it possible to live off-grid, perhaps the greatest benefit that you would enjoy from the use of solar power is that it is both a clean and a renewable source of energy. With the advent of global climate change, it has become more important that we do whatever we can to reduce the pressure on our atmosphere from the emission of greenhouse gases. Solar panels have no moving parts and require little maintenance.

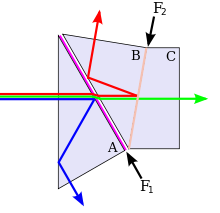
Solar panel are ruggedly built and last for decades when properly maintained. Last, but not least, of the benefits of solar panels and solar power is that, once a system has paid for its initial installation costs, the electricity it produces for the remainder of the system’s lifespan, which could be as much as 15-20 years depending on the quality of the system, is absolutely free! For grid-tie solar power system owners, the benefits begin from the moment the system comes online, potentially eliminating monthy electric bills or, and this is the best part, actually earning the system’s owner additional income from the electric company.

The solar cells you would have seen on satellites, caculaters etc are photovoltaic cells or modules (modules are a collection of solar cells electrically connected and joined together in one frame). Photovoltaics (photo = light, voltaic = electricity), convert the energy of sunlight directly into electricity. Originally expensive and only used in space, photovoltaics are now finding many applications on countless devices, buildings etc were ever remote or free and environmentally sustainable produced electricity is required.

Solar panels collect clean renewable energy in the form of sunlight and convert that light into electricity which can then be used to provide power for electrical loads. Solar panels are comprised of several individual solar cells which are themselves composed of layers of silicon, phosphorous (which provides the negative charge), and boron (which provides the positive charge). Solar panels absorb the photons and in doing so initiate an electric current. The resulting energy generated from photonsstriking the surface of the solar panel allows electrons to be knocked out of their atomic orbits and released into the electric field generated by the solar cells.

**Dichroic Prism**

Dichroic prism is used to split light into beam of different wavelength of color green, red and blue. They are usually constructed of one or more glass prisms with dichroic optic coating that selectively reflect or transmit light depending on the light's wavelength. One common application of dichroic prisms is in some camcorders and high-quality digital cameras. Set consisting combination of two dichroic prisms which are used to split an image into [red](http://en.wikipedia.org/wiki/Red), [green](http://en.wikipedia.org/wiki/Green), and [blue](http://en.wikipedia.org/wiki/Blue) components, which can be separately detected on three CCD arrays.

Digram (a)

A possible layout for the device is shown in the diagram(a). A light beam enters the first prism (A), and the blue component of the beam is reflected from a low-pass filter coating (F1) that reflects blue light (high-frequency), but transmits longer wavelengths (lower frequencies). The blue beam undergoes total internal reflection from the front of prism A and exits it through a side face. The remainder of the beam enters the second prism (B) and is split by a second filter coating (F2) which reflects red light but transmits shorter wavelengths. The red beam is also totally internally reflected due to a small air-gap between prisms A and B. The remaining green component of the beam travels through prism C.

Thus in these way there is separation of different wavelength is takes place.

**Different Doping Material**

Adding impurity in semiconductor material in solar panel called as Doping. Basically doping is used to produce p and n layer in semiconductor material. The solar cells consists mainly of silicon and is called therefore thick film solar cell, in contrary to thin film solar cells where the semiconductor layers are deposited on substrate of a different material. The bulk silicon is usually lightly p-doped, and conductive for positive charge carriers or holes. On the front side a thin heavily n-doped layer has to be formed by doping, which is conductive for negative charge carriers or electrodes.

After pn-junction is formed, which can separate the charge carrier pairs, generated by the absorption of sunlight Roll-to-roll manufacturing of CdTe solar cells on flexible metal foil substrates is one of the most attractive options for low-cost photovoltaic module production. However, various efforts to grow CdTe solar cells on metal foil have resulted in low efficiencies. This is caused by the fact that the conventional device structure must be inverted, which imposes severe restrictions on device processing and consequently limits the electronic quality of the CdTe layer. Here we introduce an innovative concept for the controlled doping of the CdTe layer in the inverted device structure by means of evaporation of sub-monolayer amounts of Cu and subsequent annealing, which enables breakthrough efficiencies up to 13.6%. For the first time, CdTe solar cells on metal foil exceed the 10% efficiency threshold for industrialization. The controlled doping of CdTe with Cu leads to increased hole density, enhanced carrier lifetime and improved carrier collection in the solar cell. Our results offer new research directions for solving persistent challenges of CdTe photovoltaic, but still using CdTe efficiency does not reach to required level hence new material is used for doping.

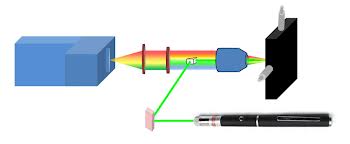
As light consisting different wavelength having different color thus it consisting different energy level depending upon energy levels. By consuming energy of these different levels efficiency can be increase thus we require to absorb these different wavelength. Light consisting three different level energy light, medium and high energy level depending upon the wavelength. As wavelength increases energy decreases thus light having high wavelength having less energy and wavelength decreases energy increases. Because energy is inversely proportional to energy red color having highest wavelength red color must have less energy and violet color posses low wavelength thus it posses high energy.

Thus by using different doping material the wavelength of different region can be absorb and efficiency can be increase. Germanium is used to absorb high wavelength thus it can be use to absorb low energy. Gallium arsenide is used to absorb the medium wavelength thus it can be use to absorb medium energy. Indium gallium phosphide is used to absorb low range wavelength thus it can use to absorb high energy.

**Way To 33% Efficiency**

Solar cell designer get tempted to pick a semiconductor that best absorb light of short wavelength, like gallium nitride. Thos photon carry the most energy and thus produce the highest voltage. Trouble is there is current is meager. Alternative designer can build cells from mercur cadmium tellurid material that can absorb the spectrum all the way high energy photon in the ultraviolet range to the low energy photon in the short wave infrared but in these case the voltage in poor thus designer must have to come up with new doping material.

As the Dichroic prism use to split light into the beam of color red, blue and green wavelength, it can be use to separate light into different energy levels. Light consisting three different level energy light, medium and high energy level depending upon the wavelength and by using these dichroic prism light can be split into different energy levels. Using different material in doping can increase our absorbing capacity and thus efficiency can be increases.



Thus by using Dichroic prism the light can be split into three different energy region and Germanium ,gallium arsenide and indium gallium phosphide doping can increase the absorbing capability of solar cell by introducing these impurity the absorption can be done from low to high energy region so simply the efficiency can increase upto 33% .

**Advantage of Dichroic prism**

When used for color separation, in an imaging system, this method has some advantages over other methods, such as the use of a Bayer filter. Most of those characteristics derive from the usage of dichroic filters and are in common with those.

The advantages include:

* Minimal light absorption, most of the light is directed to one of the output beams.
* Better color separation than with most other filters.
* Easy to fabricate for any combination of pass bands.

**References:**

[1] Ying Wu, *Student Member, IEEE*, and Hongwei Gao, *Senior Member, IEEE*

“IEEE Transactions On solar panel Technology” (Vol.55, No.6,September 2012).