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A STUDY ON SOLAR ENERY AND ITS CELLS

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ABSTRACT

Instability, high prices, waste, and environmental damage are hallmarks of the world's current energy generating system. Solar, wind, hydropower, tidal, bioenergy, and geothermal power are only few of the renewable energy sources that have been thoroughly studied. Renewable energy sources are abundant and cost nothing to use, therefore they won't destroy our natural resources. The capacity to satisfy future energy requirements at a cheap cost and without affecting the environment makes solar energy one of the plausible alternatives to fossil fuels. Due to their cheap material requirements, thin-film solar cells are a formidable foe in the ongoing battle to bring down the price of PV production. Inefficient thin film solar cells may be the result of a combination of a poor absorption coefficient and a thin active layer. Thin film solar cells have the potential to boost efficiency and decrease costs by increasing the amount of light they absorb and convert into electricity.

Keywords: - Solar, Energy, Produce, Sources.

I. INTRODUCTION

- ENERGY CRISIS: SOLAR ENERGY

It's crucial to produce energy from renewable energy sources in order to address all of these problems. Researchers are now working to collect air, water, sun, and biogas reserves. One of the most promising, affordable, and sustainable forms of energy is solar energy. Additionally, the most affordable and widely accessible energy source on planet is solar energy. Every year, the sun sends 5 X 1021 KJ of energy to the planet. The world's yearly energy requirement is 15000 times more than this energy. As a result, solar energy and its widespread use have received increased attention. According to Kumar et al., India has access to a wealth of solar energy resources. Achieving competitiveness with the retail price of electricity on a per-kilowatt-hour basis is the largest difficulty for solar energy. The cost of installation and current solar cell technologies are often high. The fact that solar energy is a clean source of energy is another important contribution. At the moment, solar energy can be used in a variety of photovoltaic systems and thermal heating techniques. Long-term forecasts suggest that photovoltaic technologies will eventually outpace solar thermal heating systems in terms of usage. The final conclusion is that although if solar energy is completely free and an ecologically friendly source, the equipment required to

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utilize it is sometimes pricey, making it difficult for researchers to access the technology. This thesis illustrates the low-cost, pollution-free advances of solar cells.

- **Generations of Solar Cells**

The evolution of solar cells focused on cost reduction has resulted in many generations, which are summarized here.

First generation: Silicon technologies

Since Si is a plentiful substance in the earth's crust, the first generation is based on the Si-wafer technology, which is often dominating. These solar cells have excellent performance to date and are extremely stable.

Second generation: Thin film solar cell

Second-generation solar cells are based on thin film solar cells (TFSCs). Thin films are simply layers of material anywhere from a few nanometres to a few micrometres thick. Thin-film solar collectors (TFSC) employ absorbers with a thickness of less than 5 mm since these materials are very efficient at soaking up solar energy.

II. SOLAR CELL PHYSICS

Early in the 20th century, Albert Einstein described the photoelectric effect, for which he was awarded the physics Nobel Prize. Prior to that, French scientist Edmund Becquerel discovered the photovoltaic phenomenon, which is the basis for how solar cell technology works, in 1839. He discovered that when metal electrodes were exposed to light during an experiment, a very modest electric current was produced. At the time, he was unable to provide an explanation for the phenomena. When he was evaluating underwater telegraph cables in 1873, British engineer Willoughby Smith made the discovery that selenium was photoconductive. American inventor Charles Fritts created the first solid-state solar cell using selenium later in 1883. The cell's efficiency was less than 1%, and its design made it impractical. A contemporary silicon-based P-N junction semiconductor solar cell with 1% efficiency was invented by Bell Laboratories semiconductor researcher Russell Shoemaker Ohl in 1940, marking the next major development. After 13 years, Bell Laboratories constructed the first usable silicon-based solar cell based on Ohl's discovery of the P-N junction. The solar cell quickly found its way into spacecraft and other terrestrial uses. Different PV technologies have been researched and developed as a result of a fundamental knowledge of underlying physics and the development of semiconductor materials.

- **Photovoltaic Effect and Solar Cell**

The device that transforms sunlight into electricity is known as a photovoltaic cell or solar cell. The conversion of electromagnetic radiation into electrical energy is the direct result of the photovoltaic effect.

- **Basic Parameters of Solar Cell**

I-V Curve

Features I-V this diagram shows how a solar cell generates electricity. A solar

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cell's I-V curve is generated by shining light onto a diode that normally operates in the dark. In dark conditions, a solar cell exhibits electrical behaviour more typical of a diode.

- **Classification of Solar Cell based on Different Materials**

Solar cells may be divided into three varieties depending on the materials they are formed of: silicon semiconductor, semiconductor compound, and other material based solar cells.

III. BASIC STRUCTURE FOR THIN FILM SOLAR CELL

The essential structure of thin film solar cells consists of numerous layers of material. The several tiers of the TFSC are discussed.

- **Buffer layer**

In order to enable the absorber layer receive the most light possible, the buffer layer must first create a heterojunction with it. Additionally, the buffer layer must have minimal absorption losses and be able to drive the photogenerated carriers with little to no electrical resistance toward the outside circuit. The buffer layer's band gap should be as high and as narrow as feasible to maintain the aforementioned requirements. Another crucial factor that contributes to the growth of the strain-free, highly crystalline absorber layer is lattice mismatch at the junction. Since 1954, CdS has been frequently used as a buffer layer owing to its many appealing qualities. CdS is an n-type semiconductor with a straight band gap of 2.42 eV.

- **Absorber layer**

The choice of absorber layer affects the TFSC's performance. In order to absorb the most visible light, the band gap of the materials utilized as an absorber layer should be in the range of 1.0 eV to 1.7 eV. Minority carriers must have a long diffusion length because it lowers recombination loss. The TFSC was developed using a variety of absorber layer materials.

CuInSe2

Copper indium selenide (CIS) is a semiconductor chalcogenide chemical that is a member of the I-III-VI group. Tetragonal chalcopyrite crystals are how it is found. The tetragonal crystal structure of CIS is seen in Figure 1.12. Since CIS or CIGS has a straight band gap and a high absorption coefficient (105 cm-1), just 1-2 m of material is needed. Figure 1.13 depicts a CIGS solar cell's optical properties.

- **Window layer**

Different transparent conducting oxide layers reported using them in solar technology. ZnO and SnO2 are two of them that are often employed in solar cell applications. Low electrical resistance and absorption should characterize the window layer. Additionally, the type of deposition employed for the window layer is crucial and should not harm the layer underneath. According to reports, the ZnO layer boosts solar cells' effectiveness.

Antireflection coating

Since absorption dominates in solar cells, reflection losses must also exist.

Researchers have started using non-transparent connections at the front surface of cells in an effort to decrease reflection losses.

Metal contact

It's crucial to choose the right metal to use as the back contact. The connections here need to be ohmic. In contrast to the metal layer that must be placed on the back of the solar cell for the superstrate configuration, figure shape connections are employed for substrate solar cells.

IV. CONCLUSION

In the present research, the use of Ag, Au, and Cu nanoparticles to enhance the solar cell's light harvesting performance was investigated. The metal nanoparticles used in this study were synthesized by a simple, low-cost two-electrode electrodeposition technique. It was found that the surface plasmon resonance (SPR) exhibited by these metal nanoparticles is affected by particle size, the surrounding dielectric environment, and the interparticle spacing. Therefore, experimental efforts were made to maximize these features while making and studying the nanoparticles, so that after being inserted in the solar cell, they may demonstrate the SPR effect mostly in the visible and NIR parts of the solar spectrum. After optimally incorporating Ag, Au, and Cu nanoparticles, the performance of the resulting TiO_2/CdS QDSSC type of solar cell was assessed. Photogenerated current, open circuit voltage, fill factor, and efficiency all saw notable boosts during the electrical test of the solar cell. The SPR effect of the solar cell's metallic nanoparticles is mostly to blame for this. According to our findings, the present research might be of considerable assistance and contribution in the areas of photovoltaics, optoelectronics, biosensors, etc.

The development of more efficient, cheaper, and more compact solar devices is urgently required today. Adding nanoparticles of noble metals like Ag, Au, and Cu to photovoltaic systems is essential for this task. This meant that plasmonics and photovoltaics may both benefit greatly from the use of nanotechnology. The present endeavor aims to use the plasmonic capabilities of nanoparticles made of noble metals like Ag, Au, and Cu to direct light into solar cells. These solar cells are more efficient since they both absorb and transmit more light. This means that the metallic nanoparticles function as a light trapping, much like the surface texturing of thick film solar cells. The most important discovery of this study is that low-cost electrodeposition can be used to produce nanoparticles of noble metals like Ag, Au, and Cu, which can then be used as a light-trapping strategy to significantly improve optical absorption and, thus, the performance of the solar cell in harvesting light.

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