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PHOTOVOLTAIC TECHNOLOGY FOR IMPROVED AGRICULTURAL PRODUCTIVITY

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Abstract

In this paper, we report how AgAIS2 (I-III-VI_2) thin films, - a chalcopyrite structure semiconductor can be used to form the power base of solar powered electric tractor. The material has band gap energy of 2.30eV and optical resistivity range of $1.31 \times 10^{-15}\Omega m$ – $1.52 \times 10^{-14}\Omega m$. The calculated optical thickness was found to be in the range of 1.497 – 1.525µm depending on the concentration of complexing agent and bath temperature. Hence, the material is a good candidate for photovoltaic cells applications.

Introduction

As the present government in the country is basically interested in reforming every facet of Nation's life via health, economy, education, politics, and agricultural sector. The greater emphasis has been on agriculture sector because of importance of food to human existence, and in this light, there is a need to consider how mass food production and distribution could be achieved at a minimal cost and without degrading our environment. Presently, the development of farm machinery and distribution system powered by fossil fuel is largely responsible for increase in productivity but due to expensive nature of world oil production, as well as, the social and environmental cost associated with oil dependence, it becomes imperative for us to look for sustainable alternatives of food production method. An ideal long-term sustainable alternatives is linked to powering of farm machinery using photovoltaic technology with the invention of photovoltaic (PV) panels, which can be used to convert solar radiation directly into electricity. The PV panels currently on the market have proven efficiencies of converting over 10% of the energy available into electricity (Heckeroth, http:www. renewable.com). This means that every square meter of photovoltaic panel exposed to sunlight is capable of producing 100watts of electricity. Photovoltaic are 30 times more efficient at converting solar energy into electricity than an electric plant powered by biofuels, and millions of times more efficient than fossil fuels.

Solar Powered Electric Tractor

Electric propulsion is the only high efficiency, zero emission technology now available to power agricultural equipment. Electric motors have only one moving part and require very little maintenance. Internal combustion engines, on the other hand, have hundreds of moving parts and required a lot of maintenance. Electric motors can operate at over 90% efficiency while combustion engines are less there 15% efficient. Electric propulsion is ideally suitable for high torque, slow speed agricultural operations. Also, electric motor can be turned into a generator while going down hill or braking returning energy to the battery. This process called regenerative braking further increases the efficiency of electric propulsion and cannot be duplicated using any other fuel. The use of electric wheel motors eliminates the need for an internal combustion engine, transmission and differential, which have always influenced the design of tractors. Mounting an electric motor in the hub creates a self-propelled wheel that offers a whole new level of versatility and visibility. The biggest problem affecting the performance of electric vehicles is the battery weight. But in case of electric tractor, it is an added advantage in the sense that the tractor performance depends on the weight for traction. In this light, heavy, deep-cycle, lead-acid batteries that are inexpensive, recyclable and long-lived can be used to great advantage. In addition to an on-board battery pack between the traction wheels, auxiliary battery packs can be self-loaded on the tractor's three-point hitches to balance implement weight and extend operating time. Electric linear actuators are used to replace inefficient hydraulics for steering and for positioning the three points hitch. The electric tractor has a separate power take off motor that can be sized for specific needs and operates independent of ground speed.

Materials and Method of Preparing Photovoltaic System ($AgAlS_2$ Thin Films).

Photovoltaic system is used to convert the solar radiation directly into electricity. Silver Aluminum Sulphide ($AgAlS_2$) thin films were coated on glass substrate by the reaction of aqueous solution of 0.2M $AgNO_3$, 1.0M $(NH_2)_2CS$, 0.1M $Al_2(SO_4)_3 \cdot 14H_2O$, 1.0M EDTA and 2.0M NaOH. Before the substrate was introduced into the reaction bath; it was degreased with $HN0_3$ solution, washed with detergent and dried in open air. This treatment is to evolve presensitized substrate surface, clean surface and nucleation site necessary for thin film formation. Thereafter, the substrate was introduced into the reaction bath and the system was allowed to stand for 43 hours 15 minutes after which the substrate was removed, washed with distilled water and dried in open air at room temperature (300k).

Also, a similar bath was prepared, and the temperature was increased to 350K and within the same time interval, the substrate was removed, rinsed and dried in open air. After deposition, Camspec M501 single beam scanning UV/VIS spectrophotometer was used to measure the absorbance and transmittance of thin films deposited using a smiliar blank substrate as a reference frame. The following formular was adopted in computation;

(i) Thickness of the film, $t = -\frac{\ln T}{\alpha}$ (1)

Where T is the transmittance, α is the absorption coefficient [Okoli et al 2005].

(ii) Optical conductivity, $\sigma_{OP} = \frac{\alpha n c}{4\Pi}$ (2)

Where n is the refractive index, and c is the velocity of light

(iii) Band gap energy, $E_g = hv - \alpha^2$ (3)

Where h is planck's constant and v is the frequency of incident radiation (Abeles, 1972).

(iv) Optical resistivity, $\sigma_{OP} = 1 —$ (4) σ_{OP}

Results and Discussion

The band gap energy of the semiconductor was found to be 2.30eV from the intercept of the straight part of the curve of the plot of absorption coefficient square against photon energy. The band gap energy of 2.30ev makes the material to be good candidates for solar cell fabrication. The variation of optical resistivity with photon energy within the visible region of electromagnetic spectrum for sample grown at room temperature (300K) showns that the resistivity increases as the photon energy decreases. This means that the material has negative correlation with incident radiction within this region.

The plot of optical resistivity against photon energy for sample grown at a temperature of 350K reveals that the material has a lower resisitivity when the temperature of the bath is increased which means that the material fabricated at higher temperature has better optical conductivity.

The variation of thickness with the concentration of EDTA can be analysed which indicates that as the volume of the ligand increases, the thickness also increases. It is also known that as the temperature increases, the thickness of the film decreases.

Conclusion

Now that the present administration is very much interested in agricultural sector than ever, there is a need to mechanize our food production process for enhanced productivity. This can be achieved by introducing farm machineries that are solar –powered. Nigeria is one of the countries of the sub-sharan Africa where solar energy is abundantly available and introduction of solar powered tractor could help to boos agricultural production. Solar powered tractor derives its working energy from the action of photovoltaic system. And silver Aluminum Sulphide ($AgAlS_2$) has proven to be a potential materials for solar cell fabrication. This is seen from the optical and solid – state properties of this material such as low optical resistivity, optimum band gap energy and moderate absorption coefficient.

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