

Graphene as Solar PV Material



Pramod Kumar Gouda, Ramesh P, Kodandapani D, M.Hari, Tejashri S Wable

Abstract-This paper studies that graphene is one of the best option for sustainable future energy requirements of world. Utilizing the blend of natural and inorganic cells makes graphene cell having uncommon highlights which encourages us to get super properties. The transparent and conductive films based on graphene were shown to be financially savvy with high thermal and electrical conductivity. Graphene is comprised of a solitary layer of carbon atoms that are fortified together in a rehashing example of hexagons. It is a 2 dimensional material with astounding qualities like amazingly solid and primarily transparent and furthermore incredibly conductive and adaptable. Graphene is made of carbon, which is bounteous, and can be a generally economical material. Graphene has an apparently unending potential for improving existing items just as rousing new ones. In this article, need of graphene material, advantage over PV material, structure, properties and utilizations of graphene are reviewed.

Index Terms: PV material, Crystalline carbon, Graphene plate, Schottky Junction's, self-illuminating

I. INTRODUCTION

Solar energy is the most important and popular renewable energy sources in recent years which are free of cost. Solar energy does not produce pollutant or by-products which are harmful to nature. We can compute the potential for each renewable energy source. Following Fig.1 shows Future development in technology will help to get more energy from renewable sources. As we know total energy demand is increasing 5% for each year. Hence to reach that huge worldwide demand, we should be use solar energy [1-3]. The solar panel is fundamental energy conversion component of a photovoltaic system. The notion of photovoltaic effect is conducted in 1839 by Edmund Becquerel. The author built up the idea of impact photo voltaic by watching the light strikes one of the cathodes of an electrolyte procedure and voltage is generated. The principal business utilization of Photovoltaic (PV) was in 1954; to screen a satellite in space that time cost

of made power was \$1000 per Watt anyway now this can be possible as \$1 per Watt [4-6]. A couple of sorts of sun fuelled frameworks which are starting at now available are given by Research Associate, Global Energy Network Institute in Review and Comparison of Different Solar Energy Technologies. Every one of them depends on very various ideas and every has its special focal points.

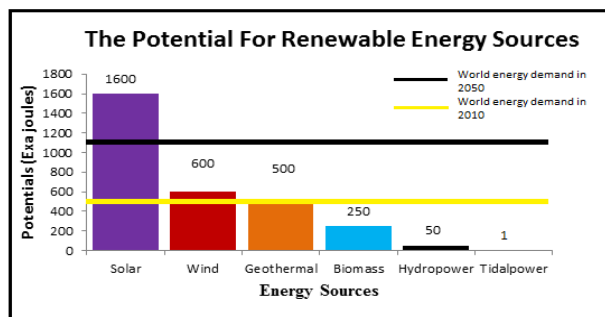


Fig.1 The potential for Renewable Energy Sources

As correlation between the various advancements will assist us with knowing the most effective innovation with a particular arrangement of conditions. Non-concentrated photovoltaic sun powered boards (PV) and concentrated sun oriented power (CSP) are the two most developed innovations. They have been popularized and expected to encounter quick development later on, accordingly their accentuation is on these two innovations. Solar thermoelectricity systems (STA), dye sensitized solar cell (DSPV) and concentrated photovoltaic frameworks are rising advances and under escalated ponder [7-9]. The Fig.2 demonstrates the different arrangement of board dependent on PV material. Silicon is as yet the principle material for assembling dynamic media in solar panel.

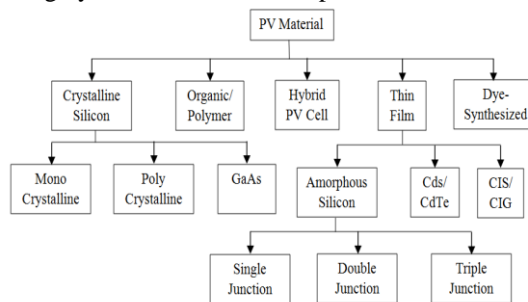


Fig.2 Classification of Panel based on PV material

Indium tin oxide (ITO) is in like manner the material which is used in solar panel at first. Yet, this material faces the impediments like staggering expense of this material,

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its high mechanical weakness, and high lethality just as restricted assets of indium on earth. So overcome this disadvantages we should use the graphene plate. Albeit sporadic endeavors to contemplate graphene can be followed back to 1859, there has been a blast in research around the material since on 2010 Nobel prize in Physics allowed to Novoselov and Geim for their work on graphene is showing of the overall vitality over the assurance of this new material structure [10-12].

II. THE WONDER MATERIAL GRAPHENE

Graphene is a quickly rising star not too far off of materials science and consolidated issue physical science. Five commonplace polymers of crystalline carbon are fullerene (for example C60, CNTs, graphene, graphite and jewel). Graphene is a molecule which is thick, two dimensional, and one of the allotropic kinds of carbon arranged every so often in a honeycomb framework. Graphene is less expensive and use less energy in electronics like smart phones because of its superior optical and thermal properties[13]. The most popular IBM exhibit graphene transistor which having special features than previous experimental transistors[14-16]. These transistors can perform 155 billion cycles per second and about 50% faster. The graphene film is shown in Fig.3.

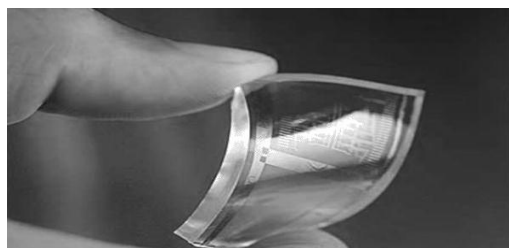


Fig.3 Graphene Film (unbreakable)

Most beneficial thing is that electrons travel in silicon is much less faster than graphene approximately 100 times less fast electrons in silicon¹⁷⁻¹⁸. On the coated surface the flow of water could produces 85 nanowatts of power from 03mm*0.15mm graphene sheet.

III. STRUCTURE OF GRAPHENE

The level monolayer of carbon firmly stuffed into a two-dimensional (2D) honeycomb cross section is called as graphene and it is fundamental wrapping component for realistic materials of every other dimensionality. It tends to be changes in to 0D, 1D, 3D by, rolling and stacking graphite separately. Above all else graphene (or —2D graphitel) has been contemplated for a long time for portraying properties of different carbon based materials. Following Forty years, it was seen that graphene having an astounding dense issue simple of (2+1)- dimensional quantum electrodynamics, which found graphene into a flourishing hypothetical toy model. Fig.4 exhibits the fundamental structure of graphene and protections between carbon particles. Graphene has level honeycomb structure which gives it a couple of, remarkable traits, including the status of the hardest material on earth.

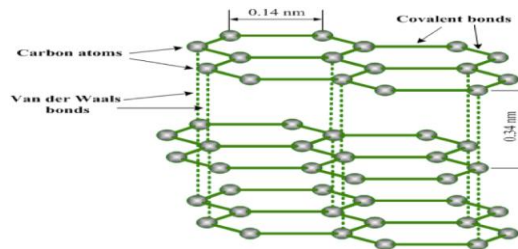


Fig.4 Basic structure of Graphene Material

IV. PROPERTIES OF GRAPHENE

4.1. Density of grapheme:

The unit hexagonal cell of graphene contains two carbon molecules and has a locale of 0.052 nm². We would thus be able to figure its thickness as being 0.77 mg/m². A theoretical lounge estimating 1m² produced using graphene would along these lines weigh 0.77 mg.

4.2. Optical transparency of grapheme:

As we probably am aware suspended graphene does not have any shading since, it ingests just 2.3% of the light force which is free of the wavelength in the optical area and Graphene is practically straightforward in nature.

4.3. Strength of grapheme:

Graphene has a breaking nature of 42 N/m. For a hypothetical steel film of a comparative thickness as graphene (which can be taken to be 3.35Å = 3.35x10⁻¹⁰ m, for instance the layer thickness in graphite), this would give a 2D breaking nature of 0.084-0.40 N/m. Thusly graphene is in abundance of various occasions more grounded than the most grounded steel. In our 1 m² lounge tied between two trees you could put a weight of around 4 kg before it would break. It ought to be possible to make a for all intents and purposes subtle lounge out of graphene that could hold a cat without breaking. The lounge would gauge shy of what one mg, contrasting with the largeness of one of the catlike's hairs.

4.4. Electrical conductivity of grapheme:

The graphene sheet conductivity of a two dimensional material is given as let the versatility is hypothetically constrained to $\mu=200,000 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ by acoustic phonons at a bearer thickness of $n=10^{12} \text{ cm}^{-2}$. The two dimensional sheet resistivity is 31 Ω and it is likewise called the opposition per Square. Our anecdotal lounge estimating 1m² would in this way have an obstruction of 31 Ω . for graphene utilizing the layer thickness we get mass conductivity 0.96 x 10⁶ $\Omega^{-1} \text{ cm}^{-1}$. This is to some degree higher than the conductivity of copper which is 0.60x10⁶ $\Omega^{-1} \text{ cm}^{-1}$.

4.5. Thermal conductivity:

The warm conductivity of graphene is commanded by phonons and has been estimated to be around 5000 Wm⁻¹K⁻¹. Graphene behaviours heat multiple times superior to copper since Copper having warm conductivity at room temperature has 401 Wm⁻¹K⁻¹.

V. CONSTRUCTION OF GRAPHENE CELL

GaAs is usually used to create high effective sun oriented cells, high electron versatility (8000cm²/V*s at 300K). This sun powered cell incorporates natural just as inorganic sort cell. The schematic structure of graphene/GaAs sun based cell is represented in Fig.5 which is made out of GaAs substrate, graphene and terminals. A SiN_x film is go about as a protecting material among GaAs and graphene. Under light procedure, electron-opening sets are photograph produced in the silicon.

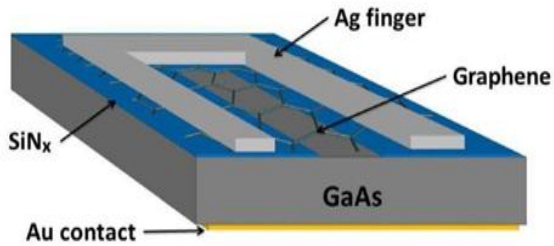


Fig.5 Construction of Graphene Cell

The photograph produced electrons and openings are isolated by the Schottky intersection's worked in electric potential and gathered by the oppositely charged graphene and semiconductor contacts. The key strides in the activity of a sun powered cell are:

1. The creation of light-produced transporters.
2. The collecting of the light-created transporters to deliver a current.
3. The creation of an immense measure of voltage over the sun based cell.
4. The lavishness of intensity in the Lord and free opposition.

An idea of improving the effectiveness of graphene silicon hetero junction sun powered cell by Optimizing Hydrocarbon Feed Rate is given by Zexia Zhang which demonstrates the outcomes demonstrate that the proficiency has been drastically improved by this technique. These all-climate sun powered boards would give an improvement to sun powered cell innovation, which as of late works just when there is adequate measure of daylight. In every climate condition that are brought about by mists and downpour, an all-climate sun powered board could supply a slick kind of imperativeness that is unimaginable with existing innovation.



Fig.6 Graphene solar cell



Fig.7 Graphene sheets

Fig.6 and Fig.7 shows the graphene daylight based cell and graphene sheets independently. After use of GPP (Graphene Photovoltaic Panel) for oneself edifying light for instance demonstrated system gives the more insightful way for illumination. It had vanquished the issues related with customary like conveniences, usage and cost adequacy on account of its basic development, little size and don't have any unique supply prerequisite.

VI. APPLICATIONS

There are certain utilizations of graphene where utilizing graphene the gadget improve its characteristics.

6.1. Batteries

These days, batteries are broadly utilized in bicycles, autos, ships, flying machines, electronic types of gear in this way step by step demanded of batteries are increments. most helpful battery lithium-particle having long life, great steadiness yet when we included graphene into anode materials has lead to prevalent electrical conductivity, high surface territory (2620 m²g⁻¹), high surface-to-volume proportion, extraordinary flimsy thickness, which can diminish the dissemination separation of particles, basic adaptability that clears the path for building adaptable terminals, warm and compound solidness which certification its toughness.

6.2. Sensors

Sensor is only gadget which identifies any physical natural amount, activity, changes and gives comparing yield in type of Mechanical, Electrical or optical sign. These sensors are utilized in contact delicate lift catches, prescription, mechanical technology, aviation and the sky is the limit from there. Sensors are ordered into dynamic and aloof sensors. At the point when joined Graphene and sensors. To get remarkable blend as graphene has one of a kind optical properties, enormous surface-to-volume proportion, high transporter portability and thickness, high warm conductivity, magnificent electrical conductivity and numerous different traits can be significantly favourable for sensor capacities. Graphene is generally used in the field of biosensors and diagnostics. By the use of graphene material the sensors will decrease and lighter - giving perpetual structure potential outcomes. They will likewise have the option to identify littler changes in issue, progressively touchy, work all the more rapidly and in the long run even be more affordable than ordinary sensors. Graphene which is utilized in nano electronic gadgets have additionally been looked into for use in deoxyribonucleic corrosive (DNA) sensors Gas sensors, PH sensors, natural defilement sensors, strain and weight sensors, and the sky is the limit from there.

6.3 Super Capacitors

Graphene-based super capacitors with a greatest explicit capacitance of 205,000 F/kg at a power thickness of 10 KW/kg and a vitality thickness of 28.5 W h/kg that likewise had a superb cyclic lifetime, holding 90% of the underlying capacitance after 1200 cycles.



6.4. Fuel Cells

During the most recent two decades, carbon nano tubes were developed as a standout amongst the most significant nonmaterial's towards energy unit applications Extensive applications, discover in power devices after the disclosure of graphene, where it very well may be utilized as a brilliant cathode material in charge of its amazing physicochemical trademark In this unique situation, platinum nano particles upheld on the graphene sheets were found to show an oxygen decrease response (ORR) movement and electrochemical surface territory.

VII. CONCLUSION

The analysis in this paper leads to a beneficial conclusion regarding the next generation polymer of crystalline carbon material 'graphene' which is all weather cell and self-illuminating solar plate. In this review work we see that to overcome disadvantages of silicon photovoltaic plate, we should use the graphene plate. The graphene transistor is 50% faster than conventional as well electrons travel in graphene 100 times more than silicon. . Density of grapheme, Optical transparency, Strength of grapheme, Thermal conductivity, Electrical conductivity these are best properties of graphene. As a result of its straightforward development, little size and don't have any extraordinary supply prerequisite it is very portable and overcome the problems associated with conventional.

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