# Graphene Coated LED based Automatic Street Lighting System using Arduino Microcontroller

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***Abstract - This paper describes about efficient automatic street lighting system using Graphene coated (Light Emitting Diode) LED. Nowadays, LED street lighting is becoming more and more popular among developing countries. But the normal LEDs are not provided with heat sink which degrades the performance of overall lighting system. Here, we are introducing GaN based LED which acts as a heat sink and it is proved that it is 10% efficient than the normal LEDs. At present, street lights are illuminating at all the time unnecessarily even in the midnight and also in the absence of human beings or vehicles, it is merely a wastage of energy. In order to overcome this problem, we have introduced automatic street lighting system using Arduino-UNO microcontroller. In this paper, the intensity of the Graphene coated LED light is adjusted based on the requirement using LDR and PIR sensors via controller. An automatic street lighting system using Graphene coated LED conserves more energy and it is cheaper too. Simulation results are provided for adjusting the intensity of the controller using Arduino controller.***

***Keywords: solar energy, battery, GaN based LED, sensors, Arduino, street lighting.***

## I INTRODUCTION

Illumination is to be considered as one of the major concerns of energy today. Hence, there must be a need to utilize renewable resources of energy [1] for illumination to conserve energy with reduced cost. Street Lighting is a chief outfit in emerging nations.

Inefficient usage of lighting deeply impacts the economic level and social stability [2]. We are intending to use solar energy for illumination which is available in abundance. In existing, street lights are continue to glow or illuminate even when there is no presence of humans/vehicles. It consumes more energy that slow down the reliability of the whole system. In this paper, we have designed a prototype which automatically adjusting the lighting system for illumination by sensing the presence of human beings or vehicles.

LED street lighting is in use due to its higher illumination and longer lifetime but when coming to high power applications heat sink is inevitable. Heat exchange across LED lights affects its lifespan and also the reliability. On the other hand when traditional LED is subjected to high current the illumination will be reduced after a certain level which degrades the performance of the system. To overcome this deficiency a small change has to be implemented. Thin epitaxial layer of LED was grown on thick sapphire. By using Laser Lift Process (LLO) the sapphire substrate was removed and tri-layer graphene was inserted [3]. This Graphene 2D structure is accepted to be an attractive option because it has higher failure strain(>10%) than Indium-tin-oxide ITO(2-3%) commonly used and it has extremely high thermal conductivity. It will act as heat sink and this LLO-LED produces higher illumination than existing LED. LLO-LED operates upto 400mA and draws less power.

Even though, solar energy is abundant in nature, world is often meeting the power demand. Since it is proved that the street lighting consumes more power, in order to conserve energy solar street lighting system can be utilized. The solar street lights also known as stand-alone street lights because it is

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independent of electrical grid. Solar panels help to convert solar energy into electricity and specifications of solar panels are depending upon the loads. The electrical energy obtained from solar panels is stored in batteries during daytime and discharged during night time. Usually, 12 volt battery is used but Ampere-hour varies with the capacity of batteries.

On the contrary, the streets lights are glowing unnecessarily even in midnights of no use so that the energy is harvested to an extent. In order to avoid this, the street lighting system needs of automation. Based on this, it will give maximum brightness only when it is needed, which is detected by Light Dependent Resistor (LDR) and Passive Infra-red (PIR) sensor. LDR senses the surrounding intensity light; whenever the environment becomes dark it triggers the controller and switches the primary circuit ON. PIR sensor senses the vehicles and humans upon a certain distance of six meter and send signal to Arduino-UNO controller which would turn on the secondary circuit too and produce maximum illumination. So by implementing this, we can save energy to an extent which is now hard to produce.

This paper is divided into following sections: Section II describes the methodology used for the proposed system. The implementation of the street lighting system is discussed in Section III. Section IV presents the results and discussions made. Finally, the paper has been concluded in Section V.

## II **METHODOLOGY**

### *a) Hardware Architecture*

Fig.1 shows the block diagram of the overall prototype of automatic street lighting system. Solar energy is absorbed by solar panel and it is converted into electrical energy which is stored into the battery with the help of buck converter. There are two major sensors, PIR and LDR are used, where PIR sensor is used to detect the presence of human whereas LDR sensor is used for sensing the light intensity. The output from these sensors is given as input to Arduino board, which controls the primary and secondary circuit individually. The whole set up is energized by the battery. The array of Graphene coated LED is connected to the output port of microcontroller.

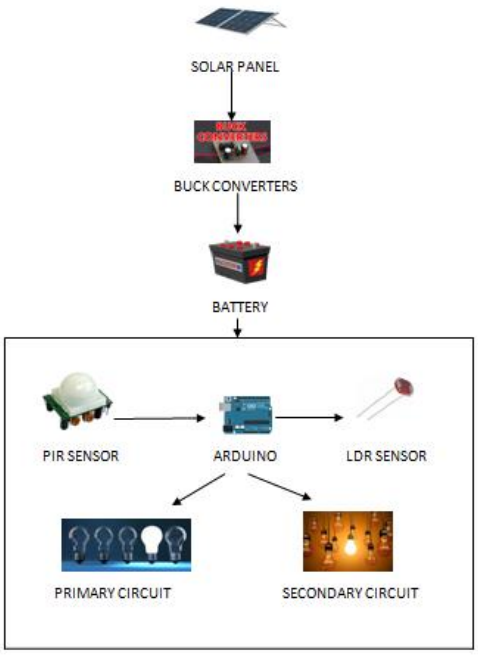


**Fig.1 Block diagram of street lighting system**

### *b) Working Principle*

The street lights are used to glow 12 hours unnecessarily. In the midnights also it glows at its full illumination even when there is less vehicles and human beings. To make it smarter and to conserve energy we have proposed a system that by using LDR and PIR sensor so that the illumination of street lights is controlled and by determining the intensity of surrounding light the street lights may be switched ON/OFF. The array of LLO-LED street lights have been divided into primary and secondary circuits. The ON/OFF movement of LLO-LEDs depends upon the input/output of sensors [4]. Light Dependent Resistor is used to detect and measure light intensity. It increases its resistance when the light intensity around the surrounding is less. When the environment is dark, LDR gives output to the microcontroller, it will switch ON the primary circuit through relays. The passive infrared sensor that measures

infrared (IR) light radiating from objects in certain direction. These are mostly used for motion detection. PIR sensor is used to detect every object that has temperature above zero and emits radiation in the form of thermal energy and to detect the human beings and vehicles that arrive in its proximity. It has a range of 6-8 meters in which they detect the human and vehicles. Whenever output from PIR sensor is received, the secondary circuit will be switched ON by the controller. The corresponding program is given to controller to obey as given criteria.

### *c) Flowchart*

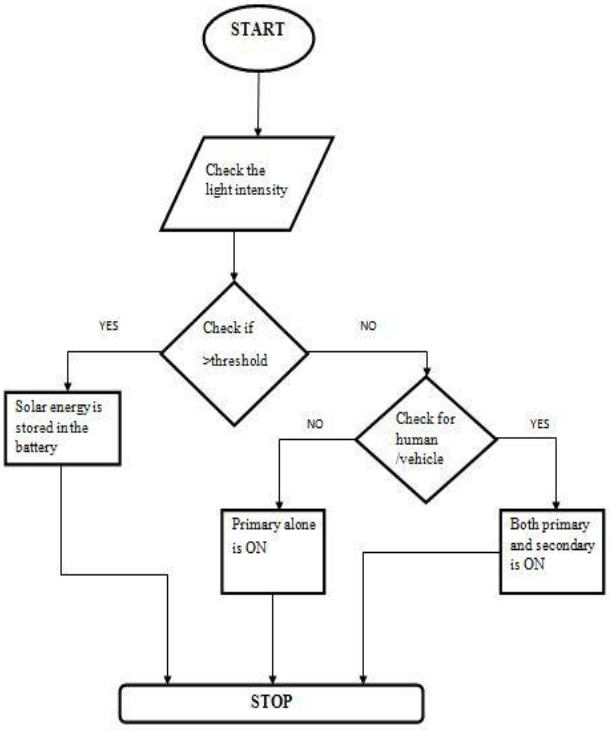


**Fig.2 Flowchart for controlling the intensity of light based on sensors input**

The light will be in OFF mode if natural light intensity is high and there is no rain or human being is sense, in this case the solar energy trapped by the solar panel is stored in the battery. Second case, if it is raining but there is no human being then the primary light will be switched ON. Finally, if natural light intensity is low and there is no rain or human being presence is detected then also only primary light will be in ON state and if there is rain and human presence is detected then both the primary and secondary light will be in ON mode. This concept is briefly described in Fig.2. Thus street lights glow whenever it is necessary and also the illumination can be controlled. By implementing this more energy can be conserved.

## III IMPLEMENTATION PROCESS

### *a) Graphene-coated LED*

BarteringGaN LED wafers with InGaN/GaN multi-quantum-wells were developed on sapphire substrates by the metal-organic chemical vapor deposition technique. Sapphire substrate was ejected by employing Laser Lift-Off (LLO) method. For the LLO process, an ArFexcimer laser entity with a wavelength of 193 nm (JPSATM IX-260) was used to drive the sapphire substrate off.

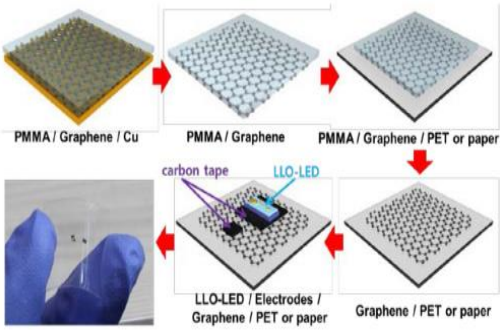


**Fig.3 Process of manufacturing graphene coated LED**

Fig.3 shows the step-by-step process of making a graphene coated LED filament. Trifilmgraphene on Poly methyl methacrylate (PMMA) or paper substrate was infused in lieu of sapphire. Paper substrate used on deck could be nip from fiscal clear area binder because it is firm and chemically unassailable. As sapphire is broad and inelastic and meanwhile it gets in to heat shift it won't act as heat drop, which act on LED's life span. The layer impediment of the graphene can be under control by altering the count of the graphene lamina or installing the chemical dopants. Despite, graphene is

priceybutwhen LLO-LED on graphene production was enlarged its rate was nether than regularLED. First graphene and PMMA was coated on both sides by copper foils. These copper foils were removed by making this layer to react with certain chemicals. The paper substrate was added to this substrate for higher sheet resistance. Sapphire removed LLO-LED were placed in this graphene cum paper substrate and it was fixed by Ag paste or carbon tape.

LEDs used in quality street light luminaries are frequently assigned as High Power LEDs and are mostly distant from other LEDs used in automobile brake lights. Normally, the life span of an LED street light can exceed 50,000 hours, which is almost equal to six years of continuous operation which equates to 12 years of life when in operation 12 hours a day. In this, the heat dissipation was high and no proper heat transfer was obtained. As a result its lifetime may be reduced. By implementing graphene coated LED it will act as a heat sink and its lifetime is achieved greater than the traditional one. The light output power of the regular LEDs on sapphire increased with increasing current up to about 225 mA, saturated at around 225 mA, and gradually degraded when the operation current exceeded 270 mA [8]. On the other hand, the light output power of the LLO-LEDs on Cu increased with increasing current up to about 225 mA and maintained the same power level after exceeding 225 mA, and was still operational up to 400 mA, suggesting superior heat dissipation with the graphene substrate and also allowing higher current operation with higher light output [8]. The illumination of LLO-LED is higher than traditional LED street lighting and consumes less power.

***b) Arduino UNO microcontroller***

Arduino-UNO is a ATmega328P microcontroller. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Arduino is designed to control street light using light sensor and passive infrared sensor by measuring the intensity of light or the presence of human/vehicle. Street light is controlled automatically with the help of intensity of light, by sensing the presence of human/vehicle. Relay is used to provide isolation between Arduino and supply to Street light. The development board of Arduino-UNO is shown in Fig.4.

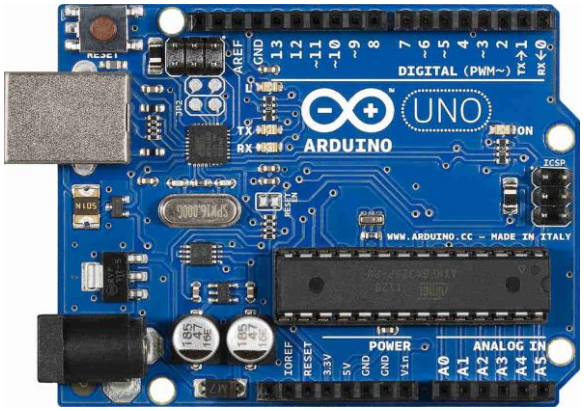


**Fig.4 Arduino UNO development kit**

## IV RESULTS AND DISCUSSIONS

The hardware prototype of street lighting system has microcontroller which controls the overall system of solar energy conversion and usage of solar energy. The movement of vehicle or human being is sensed by PIR sensor. LDR will sense the intensity of light and send it to microcontroller. According to the signal received, the controller turning ON/OFF of street lights alternatively. The Pulse Width Modulation (PWM) signal is generated to change the ON/OFF time of street lights based on our requirement. The code for PWM is downloaded in Arduino-UNO development board and the arrays of LEDs are connected to the output port of the microcontroller. The generated PWM signal using Proteus software is shown in Fig.6.and its corresponding code compilation is shown in fig.5.

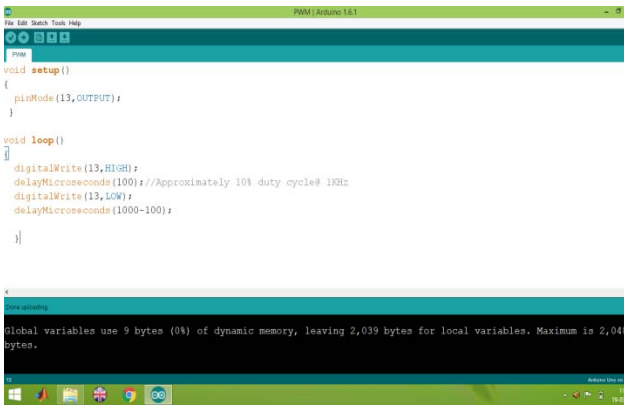


**Fig.5 Compiling the code using Arduino**

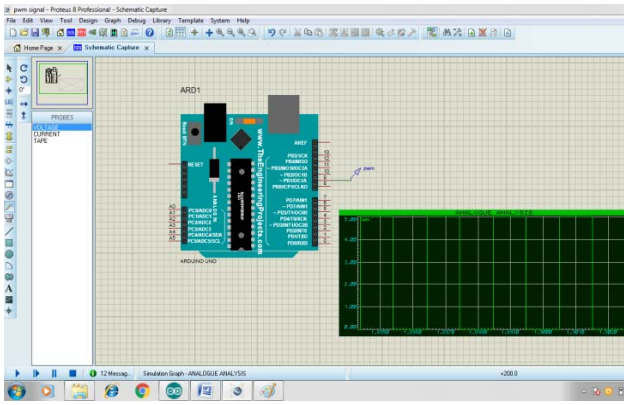


**Fig.6 PWM generation using Proteus software**

By implementing this prototype, energy is conserved more as the light switches can be ON or OFF automatically at applicable time and also manual effort is eliminated completely. The Automatic street light controller unit fabrication is cost-effective with good sensitivity and higher predictability. The implementation is also simple and can be implemented using available materials or components. The LEDs are ON/OFF whenever it is needed. Hence, power consumption is totally reduced. It can be used for some other purposes like garden lighting, balcony lighting, highways, garage etc.

## V CONCLUSION

This paper has presented the idea and design of an efficient street lighting system using Graphene coated LED. And also, it describes about automatic controlling of street lights using LDR and PIR sensors. Each sensor controls the turning ON or OFF of the lighting column using Arduino-UNO microcontroller. Hence by using Graphene coated LED and by controlling arrangement it benefits us by conserving more energy.

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