

Performance Analysis of Organic Solar Cell with Reduced Graphene Oxide, Sunflower Seed and Mutated Green Algae

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Abstract: This paper describes the performance of organic solar cell performance with reduced graphene oxide, sunflower seed and mutated green algae. This work aimed to analyze the open circuit voltage and short circuit and hence to enhance the performance of organic solar cell. The work was carried out in the laboratory. The performance analysis of organic solar cell with mutated and un-mutated green algae was also done in this work to observe the effect of mutation on the performance of solar cell.

Index Terms: green algae, graphene oxide, reduced graphene oxide, genetic transformation

I. Introduction

Solar energy is among the most abundant available renewable energy. The materials which convert this solar energy into different form of energy can be classified as inorganic and organic materials. The factors which affect the conversion efficiency are material and medium of conversion. Initial developments used inorganic materials for the conversion. Now days, due to advancements in technology, organic materials are gaining popularity and due to this researchers are now focusing on the development of organic based solar cell for the conversion of solar energy. The organic materials can be added in different proportions to get desired output.

Nature along with human being is responsible for the pollution, but in contrast to human being nature recycles the waste with the help of materials and various organisms. Among these materials and organisms, various types of algae are play a vital role in maintaining the

level of pollution specially the level of the carbon dioxide. The various types of algae are green, red brown, etc. , out of which green algae has best property to maintain the level of carbon dioxide and transform the energy. Life cycle of algae is shown in Fig. 1.

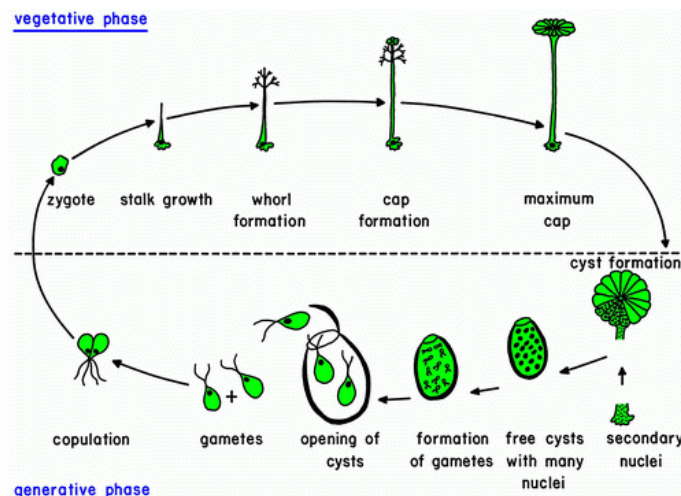


Fig. 1 Algae life cycle

Sun-flower plant shows satisfactory response towards external stimuli and hence satisfactory response towards sunrays in comparison to other plants. Since most of the plants grow from their seeds, seed of sunflower will show same feature.

Graphite conducts electricity as it has one free pi-electrons in its crystal structure. Graphene has 2-dimensional one-layer hexagonal structure of graphite [1]. Graphene-oxide and reduced graphene oxide, compounds of graphene, show response towards light. Reduced graphene-oxide has better response as well as mobility characteristic than graphene oxide. This can be confirmed from Fig. 2, Fig. 3 and Fig. 4.

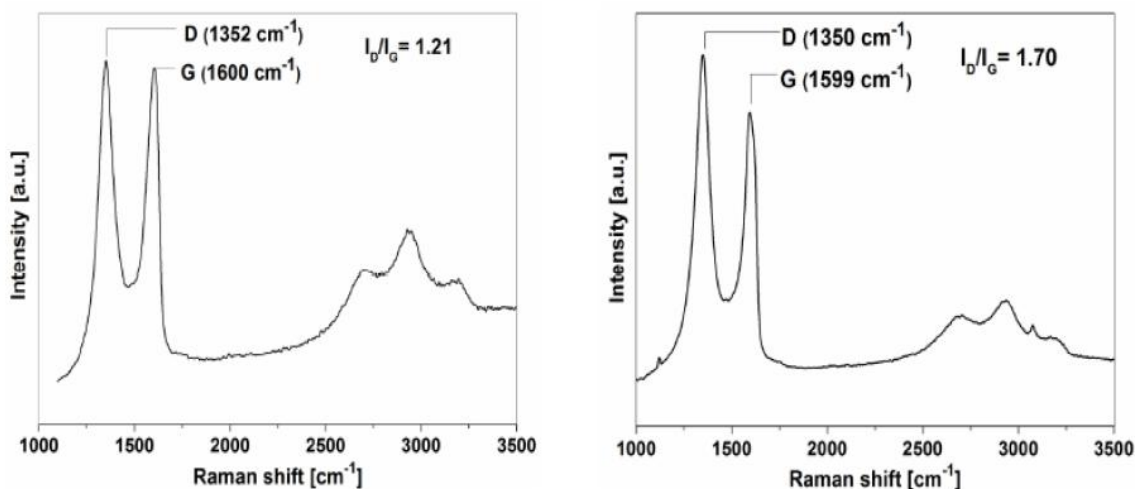


Fig. 2 Graphene Oxide Raman Spectra (left) and Reduced Graphene Oxide Raman Spectra (right)

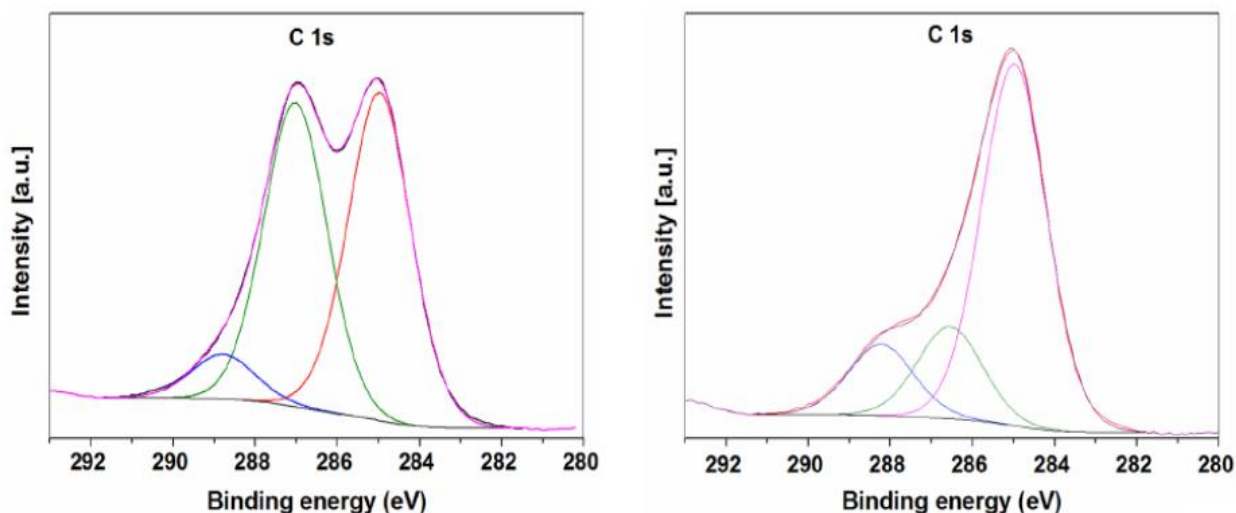


Fig. 3 Graphene-Oxide X-ray photoelectron spectroscopy spectra (left) & Reduced Graphene Oxide X-ray photoelectron spectroscopy spectra (right)

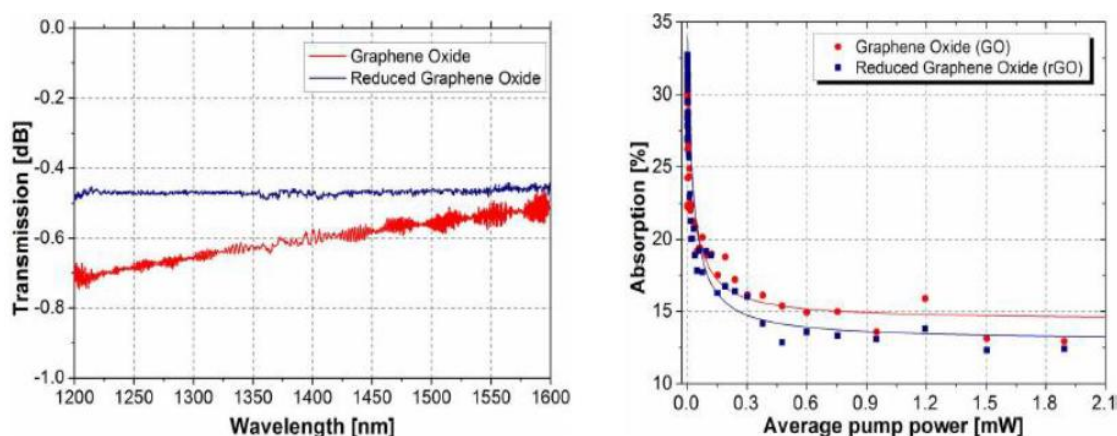


Fig.4 Linear transmission spectrum (left) & power-dependent transmission (right) of the Graphene Oxide (red) and Reduced Graphene Oxide (blue)

Fig. 2 shows the behavior of graphene-oxide and reduced graphene-oxide for a light ray of approximately four hundred nano-meter. Fig. 3 shows the binding energy of Graphene oxide and Reduced Graphene Oxide from which we can conclude that later has better electron mobility. Fig. 4 shows that Reduced Graphene Oxide has better transmission efficiency than Graphene Oxide [2].

This work gives a brief idea about the use of green algae as to generate electricity with sun flower seed and reduced graphene oxide along with air purifier agent. One research survey shows that green algae has better capability to absorb green house gases than tree for the same volume of algae and tree [5] [6] [7].

II. Information of materials

Green algae, ancestor of tree, have the characteristic that it never dies. It only goes in inactive state and becomes active whenever the environment becomes favorable. The green leaves 4 types of chlorophyll but algae have 2-types of chlorophyll i.e. chlorophyll A and chlorophyll B. This property of green algae plays a very pivotal part in the processing of photons [3]. *Chlamydomonas reinhardtii* was taken for the test of green algae as sample [8]. Gene mutation can be applied to increase the content of chlorophyll-A & chlorophyll-B. Fig. 5 shows the main steps of genetic transformation.

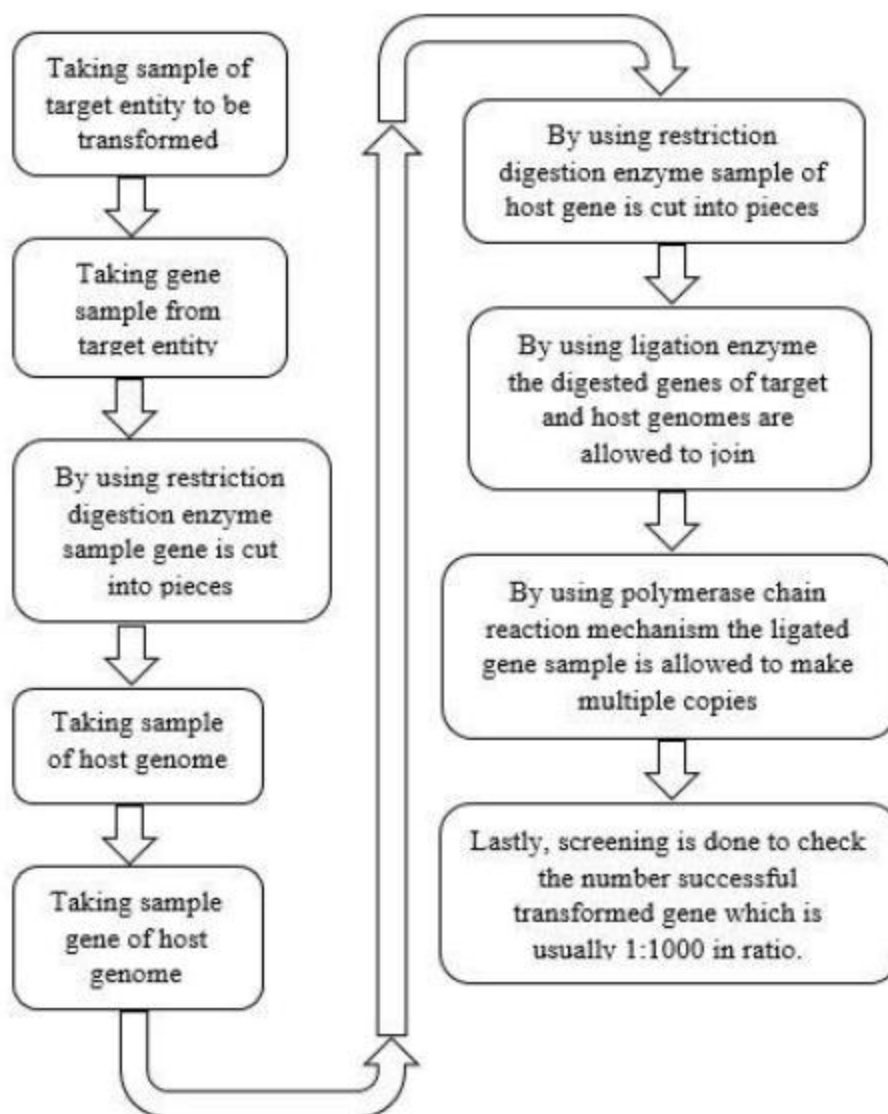


Fig. 5 Flow chart for the genetic transformation

Modified hummer's method was used to derive Reduced Graphene Oxide graphite rod. Graphite rod was obtained from commercially available torch. The chemical process followed for this process are:

- i) Mixing and stirring of 2-grams crushed graphite powder obtained from graphite rod done for thirty minutes in hundred milliliters of ninety eight percent concentrated sulphuric acid. Ice cubes in a large bowl made of fiber have been used to keep the temperature around five degree Celcius.
- ii) Addition of 20 milliliter hydrogen peroxide.
- iii) Addition of eight grams of potassium permanganate. Ice cubes were used in addition to the above to maintain the temperature at 10°C.

Then above mixture was stirred for approximately one hour. Temperature of ten degree Celsius was kept for this duration.

- iv) Distilled water and five percent concentrated HCl were added to make pH-6 so as to remove heavy metal particles from the test mixture.
- v) Graphene oxide was obtained after following the drying process this mixture for 24 hours at ninety five degree Celcius in hot air oven.
- vi) Exfoliated Graphene Oxide can be obtained by repeating steps IV and V.
- vii) For Reduced Graphene Oxide steps IV and V were followed repeatedly on exfoliated Graphene Oxide but the quantity of distilled water was eight hundred milliliters in this case [4].

III. Test and Results

Fig. 6 shows the reduced graphene oxide obtained after following above mentioned steps.



Fig.6 ReducedGraphine Oxide

The steps followed for the testing are as follows:

- i) To weaken the bonding and hence to obtain better interaction with other counterpart material to be mixed in next testing steps, this aqueous solution of sun-flower seed flour was boiled.
- ii) This solution is then mixed with Reduced Graphene Oxide in water.
- iii) Flour of sun-flower seed and Reduced Graphene Oxide, 1gm each were mixed and previously mentioned steps were followed.

0.629V open circuit voltage was successfully achieved as shown in Fig. 7.

In case of green algae open circuit voltage was checked for un-mutated and mutated algae. The open circuit voltage of 0.184 volt was achieved and due to mutation value increased significantly to 0.490 volt as shown in Fig. 8 and Fig. 9. The open circuit voltage of 0.62 volt was obtained with mutated algae and Reduced Graphene Oxide.

The sunflower seed flour, Reduced Graphene Oxide and mutated green algae were mixed to get better short circuit current. The order of addition was, Reduced Graphene Oxide, sunflower seed flour which was boiled prior to mixing to weaken the binding force between the molecules and green algae. A short circuit current of three mill amperes was obtained as shown in Fig. 10.



Fig.7 Open Circuit Voltage for Sun-flower seed flour with Reduced Graphene Oxide



Fig. 8 Open-circuit voltage of un-mutated Algae

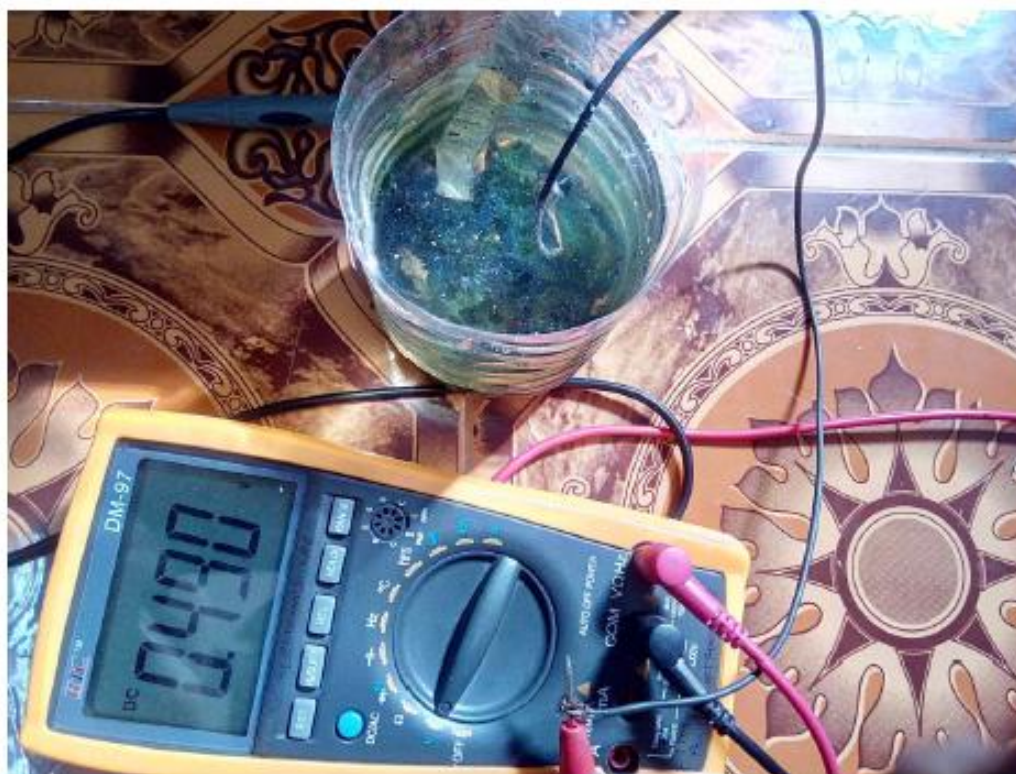


Fig. 9 Open Circuit Voltage of mutated algae



Fig.10 Short Circuit Current with Sun-flower seed flour and Reduced Graphene Oxide

IV. Conclusions

The results in laboratory shows that this incorporation of green algae, seed flour of sun-flower and Reduced Graphene Oxide for an organic solar cell gives better open circuit voltage to a large value and for short circuit current, reduced graphene oxide plays important role. Genetically transformed green algae has improved open circuit voltage, hence addition of genes of sun-flower seed or mutated algae of same can give better results. Green algae gave a significant open circuit voltage but the genetic mutation can be done to get more property of green algae such as self-illumination. This can be done by incorporating green fluorescent protein. Genetic editing can also be done making hybrid part which has the property of sun-flower seed and algae as well. Combining features of graphene, green algae and sun-flower seed may increase the stability and durability and hence limit the space of electrolyte.

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