

An Experimental Investigation on E-Bike by Using Graphene Battery

Chokkalingam.P¹, Malarkodi.P.², Anbarasu.³, Diwakar.D⁴, Gobinath.D⁵, Gowtham.R⁶

¹, Assistant professor,^{3, 4, 5, 6} Students, Department of Mechanical Engineering, Erode Sengunthar Engineering College, Thudupathi, Erode.

², Assistant professor, Department of Physics, Kongu Engineering College, Perundurai, Erode.

***Corresponding Author**

pchokku73@gmail.com

(P.Chokkalingam)

Tel.: +919788983132

ABSTRACT: In this paper we summarises a product that may increases the power storage capacity, life, eco-friendly and overall efficiency. Electric cycles are now becoming the main vehicles for short distance trip because of their speediness, flexibility and convenience. The environmental impact and energy consumption in production and use were quantified and compared with other compacting modes of transport such as buses, bicycles, motorcycles and cars. The input power to store energy in the battery is derived from rotational energy of rear wheel through the principal of electromagnetic induction. A graphene-based battery is used in this system, which is a major source for the energy.

Keywords: Graphene and E-bike

1 Introduction

Through ages, man has becoming more innovative in discovering new materials cost reduction techniques aiding life to exist far better. In this paper, we summarise a product that may increases the power storage capacity, high speed charging, life, eco-friendly and overall efficiency. Electric cycles are now becoming the main vehicles for short distance trip because of their speediness, flexibility and convenience. The environmental impact and energy consumption in production and use were quantified and compared with other compacting modes of transport such as buses, bicycles, motorcycles and cars. The input power to store energy in the battery is derived from rotational energy of rear wheel through the principal of electromagnetic induction. A graphene-based battery is used in this system, which is a major source for the energy.

Graphene

Graphene is an allotrope (form) of carbon consisting of a single layer of carbon atoms arranged in a hexagonal lattice, and a novel material with just a single layer of carbon atoms in a two- dimensional lattice, was discovered in 2004 by A K Geim and K S Noveselov through a mechanical method and has attracted tremendous attention for a wide variety of applications.

The material possesses unique physical properties, such as intrinsic carrier mobility ($200\ 000\ \text{cm}^2\ \text{v}^{-1}\ \text{s}^{-1}$), excellent mechanical strength(1100Gpa), superior thermal conductivity ($5000\ \text{w}\ \text{m}^{-1}\ \text{k}^{-1}$), high electrical conductivity ($106\ \text{U}\ \text{cm}$) and almost complete transparency in visible light (97.7%). All of the properties mentioned above make graphene one of the most promising materials for applications in electronics, photonics, composite materials and several other fields. The synthesis of graphene by several routes has been investigated.

Mechanical exfoliation results in quite high-quality graphene. But it is impossible to scale up its production. Chemical vapour deposition using copper or nickel as catalysts can grow large area and high-quality graphene. However, this technique needs to be performed under strict conditions, which may restrict the materials production at a reasonable price. Chemical exfoliation based on hummers method can produce grapheme derivatives in large quantities.



2. Methodology

Hummer's Method

A rapidly increasing list of graphene production techniques have been developed to enable graphene's use in commercial applications. Isolated 2D crystals cannot be grown via chemical synthesis beyond small sizes even in principle, because the rapid growth of phonon density with increasing lateral size forces 2D crystallites to bend into the third dimension.



Hummer's method is a chemical process that can be used to generate graphite oxide through the addition of potassium permanganate to a solution of graphite, sodium nitrate and sulfuric acid. It is commonly used by engineering and lab technicians as a reliable method of producing quantities of graphite oxide. It is also able to be revised in the creation of a one-molecule-thick version of the substance known as graphene oxide.

3. Centrifugation

The centrifugation is a technique which involves the application of centrifugal force to separate particles from a solution according to their size, shape, density, viscosity of the medium and rotor speed. This process for washing graphene oxide by using acetone, ethanol and distilled water in 4000 rpm for each 10 minutes. The process reduced the pH level of the graphene oxide by using distilled water.

4. Graphene Electrode

To create the electrode, graphene is dispersed in ethanol until a concentration of 0.2 mg mL^{-1} is achieved. The resulting suspension is filtered by vacuum filtration and then

collected on the microporous filter paper. The filtered graphene is cut into $1 \times 2 \text{ cm}^2$ (1 mg weight) for subsequent use. It is attached to a cell with an electrolyte buffer in order to examine the graphene electrode.

5. Processing

Batteries generally require several chemical reactions in order to operate. At least one reaction occurs in or around the anode and one or more reactions occur in or around the cathode. In all cases, the reaction at the anode produces extra electrons in a process called oxidation, and the reaction at the cathode uses the extra electrons during a process known as reduction. When the switch is closed, the circuit is complete, and electrons can flow from the anode to the cathode. These electrons enable the chemical reactions at the anode and cathode.

In essence, we are separating a certain kind of chemical reaction, a reduction-oxidation reaction or redox reaction, into two separate parts. Redox reactions occur when electrons are transferred between chemicals. We harness the movement of electrons in this reaction to flow outside the battery to power our circuit.



6. Oxidation Reaction (Anode)

This first part of the redox reaction, oxidation, occurs between the anode and electrolyte, and it produces electrons (e^-). Some oxidation reactions produce ions, such as in a lithium-ion battery. In other chemistries, the reaction consumes ions, like in the common alkaline battery, in either case, ions are able to flow freely through the electrolyte where electrons cannot.

7. Reduction Reaction (Cathode)

The other half of the redox reaction, reduction, occurs in or near the cathode. Electrons produced by the oxidation reaction are consumed during reduction. In some cases, like lithium-ion batteries, positively charged ions are consumed during reduction. In other cases, like alkaline batteries, negatively charged ions are produced during reduction.

8. Aluminium or Aluminum

Aluminium or aluminum is a chemical element with symbol Al and atomic number 13. It is a silvery-white, soft, nonmagnetic and ductile metal in the boron group. By mass, aluminium makes up about 8% of the earth crust; it is the third most abundant element after oxygen and silicon and the most abundant metal in the crust, though it is less common in the mantle below. The chief ore of aluminium is bauxite. Aluminium metal is so chemically reactive that native specimens are rare and limited to extreme reducing environments. Aluminum is remarkable for its low density and its ability to resist corrosion through the phenomenon of passivation.

9. Preparation

Here the preparation of aluminium as anode is done by mixing the aluminium powder and the mineral oil (silicon gel) in the ratio of 7:3 in the form of slurry state and made coating over the stainless-steel plate. This setup is covered with aluminium foil and kept at 200°C for 2 hours. In this mineral oil (silicon gel) used as a binder, instead to get pure homogeneity PVDF (polyvinyl difluoride) or PTFE (Poly Tetra Fluoro Ethylene) or SBR (styrene-butadiene rubber) is used, and instead of using normal grade stainless steel, stainless steel-112 is used for more effectiveness.

Electrolyte

Normally an electrolyte is a substance that produces an electrically conducting solution when dissolved in a polar solvent, such as water. The dissolved electrolyte separates into cations and anions which disperse uniformly through the solvent. Electrically, such a solvent is neutral. If an electric potential is applied to such a solution, the cations of the solution are drawn to the electrode that has an abundance of electrons, while the anions are drawn to the electrode that has a deficit of electrons. The movement of anions and cations in opposite directions within the solution amounts to a current. This includes most soluble salts, acids and bases. Some gases, such as hydrogen chloride, under conditions of high temperature or low pressure can also function as electrolytes.

12. Charge Collector

The structure within a battery electrode that provides a path for the electric current to or from the active material. Also known as current collector.

10. Construction

Battery Manufacturing

The battery consists of 6 sections, in series and parallel configuration we have obtained the advantages of the both. A 6 volt has induced in each section of the battery, by the series configuration the amount of voltage to each section is combined, so that the output voltage obtained will be at 36 volt. For the series parallel configuration, a jumper wire is used which is connected through each section in the battery, the connection is made by connecting one end of the wire to anode in one section and another end of the wire to the other section, and this is continued to the last section. The remaining cathode and the anode are taken for the output.

11. Working Principle

Batteries are a collection of one or more cells whose chemical reactions create a flow of electrons in a circuit. All batteries are made up of 3 basic components: anode, cathode and electrolyte. When the anode and cathode of a battery is connected to a circuit, a chemical reaction takes place between the anode and the electrolyte. This reaction causes electrons to flow through the circuit and back to the cathode where another chemical reaction takes place. When the material in the cathode or anode is consumed or no longer able to be used in the reaction, the battery is unable to produce electricity. At the point battery is dead. Batteries that must be thrown away after use known as primary batteries. Batteries that can be recharged are called secondary batteries.

A battery works on the oxidation and reduction reaction of an electrolyte with metals. As the result of oxidation reaction one electrode gets negatively charged called cathode and due to the reduction reaction, another electrode gets positively charged called anode. The cathode forms a negative terminal whereas anode forms the positive terminal of the battery.

Merits

- Graphene battery can be light weight
- Higher capacity
- More efficiency when compared with other batteries

Demerits

- Battery making is quite complex

- Band gap not suitable to simply get the switching on and off

13. Conclusion

Graphene oxide (GO) was successfully prepared by oxidizing purified natural flake graphite (NFG) by a modified Hummer's method. GO was later thermally reduced to synthesize reduced GO. The GO synthesized by the modified Hummer's method was found to consist of stacks of GO sheets.

A graphene based 36v battery was successfully made, that is good enough storage capacity to run a e-bike. The objective of a comfortable, compact, high speed and efficient bicycle can be achieved by this various experiment results obtained by different authors by advancement in current E-bike model. In future further more advancement in graphene battery maybe create a major role in the energy sectors. In the next era it will place an important part than in the current era.

References

- [1] Nosolev, K.S., Geim, A.K., Morozov, S.V., Jiang,D.,Zhang, Y., Dubonos, S.V., Grigorieva, I.V. and Firsov, A.A (2004) Electric field effect in atomically thin carbon films. *Science*, 306, 666-669.
- [2] Geim, A K. and Novoselov, K.S, (2007) The rise of graphene, *natural ,materials*, 6, 183-191.
- [3] Eluyemi, M.S., Eleruja, M.A., Adedeji, A.V., Olofinjana, B., Fasakin, O., Akinwunmi, O.O., Ilori, O.O., Famojuro, A.T., Ayinde, S.A. and Ajayi, E.O.B. (2016) Synthesis and Characterization of Graphene Oxide and Reduced Graphene Oxide Thin Films Deposited by Spray Pyrolysis. *Graphene*, 5, 143-154.
- [4] Hayes, W.I., Joseph, P., Mughal, M.Z. and Papakonstantinou, P. (2014) Production of Reduced Graphene Oxide via Hydrothermal Reduction in an Aqueous Sulphuric Acid Suspension and Its Electrochemical Behaviour. *Journal of Solid State Electrochemistry*, 19, 361-380.
- [5] K. Schleinitz , T. Petzoldt , L. FrankeBartholdt , J. Krems , T. Gehlert, The German Naturalistic Cycling Study – Comparing cycling speed of riders of different e-bikes and conventional bicycles, *ScienceDirect- Ekseveir July- 2015*
- [6] Ajinkya Parab, Ankit Kamath, SatwantSingh Rajpurohit, Zeeshan Mulla , Urban Electric Bike , *IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 02, 2015 ISSN (online): 2321-0613*
- [7] Iodice P, Senatore A. Appraisal of pollutant emissions and air quality state in a critical Italian region: Methods and results. *Environmental Progress and Sustainable Energy* 2015;34:1497-1505
- [8] C. Abagnale, M. Cardone, P. Iodice, S. Strano, M. Terzo, G. Vorraro, Power requirements and environmental impact of a pedelec. A case study based on real-life applications, *Environmental Impact Assessment Review*, 53 (7) (2015), pp. 1–7, doi:10.1016/j.eiar.2015.02.003.