National Conference on Recent Trends in Synthesis and Characterization of Futuristic Material in Science for the Development of Society
(NCRDAMDS-2018)
In association with
International Journal of Scientific Research in Science and Technology

Application of Graphene Quantum Dots in Electronics and Photonics

A. A. Wadatkar, S. A. Waghuley
Department of Physics, Sant Gadge Baba Amravati University, Amravati, Maharashtra, India

ABSTRACT

The Graphene quantum dots (GQDs) represent new class of quantum dots with unique properties. These quantum dots mainly possess graphene lattice inside the dots smaller than the 100 nanometers in size and less than 10 layers in thickness. GQDs which are defined as the zero dimensional carbon nanostructure comprising single or few layer graphene with small size distribution mainly in range of 3 to 20 nanometre have attracted significant interest, because of their ultra small and uniform sizes, unique photoluminescence properties and low toxicity. These advantages make GQDs very promising for various applications such as Bioimaging, Biosensing, Drugs/Genes delivery. This review deals with the synthesis method and applications if GQDs in electronics and photonics.
Keywords: Graphene; quantum dots; electronic and photonics applications

I. INTRODUCTION

Nanotechnology is the media with which we can create devices and machines in the range of nanometre scale, which is billionth of meter, about half the width of human DNA molecule explained by Paul McEwen. Hence one of the applications of nanotechnology called Quantum dots, we will undergo through the graphene quantum dots to understand and later implement with our new idea. A quantum dot is a nanoparticle made of any semiconductor material such as Silicon, Cadmium selenide, and Cadmium sulphide. These have a special property to glow with a particular colour after being illuminated by light. Fluorescent graphene quantum dots have attracted tremendous attention because of their unique two dimensional layered structures, large surface area, good water stability, tunable fluorescence, high photo stability, excellent biocompatibility and low toxicity which makes them promising candidates for the applications in various fields, such as imaging and biosensors.

In normal solar cells, the photon of light generates one electron. But experiments with both silicon and lead sulphide quantum dots can generate two electrons for single photon of light. Therefore, using Quantum dots in solar cell could significantly increase their efficiency in producing electric power. To date, various synthetic approaches have been developed .synthesis of GQD's which can be classified into two strategies. Researchers are also working on the use of Quantum dots in displays for applications ranging from your cell phone to large screen television that would consume less power than current displays. By placing different size quantum dots in each pixel of display screen, the red, green and blue colour used to generate the full spectrum of colours would be available.

One is Top Down approach involving cleavage of carbonaceous materials via physical, chemical or electrochemical processes. Alternatively, GQDs can be synthesized via a bottom up approach involving solution chemistry cyclodehydrogenation of polyphenylene precursors or carbonizing certain organic precursors. Let us take a brief look of some synthesis methods of GQDs.

II. SYNTHESIS METHODS

1. Gqds derived from carbon fibre:

Here in this, there are the chemically exfoliated traditional pitch based carbon fibres, during acidic treatment, the stacked acidic sub micrometer domain of fibres are easily broken leading to creation of gqds.

These have size up to about 1 to 4 nanometre. These are proved to have less cytoxity and excellent biocompatibility. Hence it can be used as an ecofriendly material in Bioimaging and Biolabelling. [1]

2. Electron lithography method:

This is one of the specialised techniques to create extremely fine pattern which is visible by naked eye. Broadly this method can be introduced as scanning of beam of electrons which is covered with the resist film which is sensitive for the electrons causes to deposited the energy in a particular manner called pattern in that resist film.

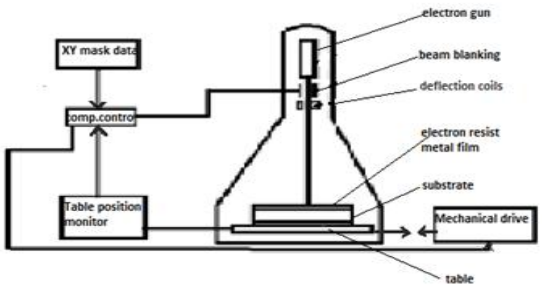

Figure 1. Experimental setup for electron lithography method

3. Pyrolysis of citric acid method:

It is single step synthesis of gqds. Here, pyrolysis of citric acid is carried out by adding sodium hydroxide to maintain pH. Then citric acid decomposes into hydronium ion. It acts as a catalyst in decomposition reaction. Aromatic clusters get formed via aldol condensation. After adding sodium hydroxide the gqds with different pH get form. [2]

4. Ball milling method:

Ball mill is a type of grinder used to grind & blend materials that are used in mineral dressing process, paints, pyrotechnics, ceramics and selective laser sintering. It works on principle of impact and attrition. Ball mill is a type of grinder used to grind & blend materials that are used in mineral dressing process, paints, pyrotechnics, and selective laser sintering. It works on principle of impact and attrition. Size reduction is done by impact as the balls drop from near the top of the shell. Diagrammatically it can be given as.

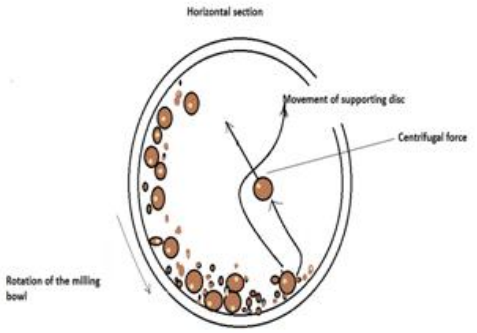

Figure 2. Ball milling method

5. Gqds with highly efficient blue emission:

It is the rapid method to produce gqds that exhibit optoelectronic properties. Here they used pulsed laser exfoliation process. In this technique with pulsed laser ablation, gqds are exfoliated from multiwall carbon nanotube (MWCNTs). Within six minutes the MWCNTs transformed into gqds. This method opens up the new ways to prepare different optoelectronic nanomaterials. These gqds show distinct blue photoluminescence with excellent quantum yield up to 12% [3].

6. Gqds from Mangifera indica:

In this the gqds are manufactured by the mango leaves. They fabricated the red luminescent graphene quantum dots with ethanolic extract of mangifera indica. Its size is found to be 2 to 8 nanometre. It exhibits the excitation independent fluorescence emission in near infrared region between 650 and 750 nanometer. This is a green synthesis route using different carbon source like fruit, leaves, extract, peels, bacteria etc.

III. APPLICATIONS

Recently the GQDs have been recognised as an attractive building block for the various applications like electronics, photonics and also in bio molecular devices. Some of these are as follows.

1. GQDs are applied to sensors for photoluminescence, humidity, biomolecules and electrochemical luminescence.
2. These are applied to electrodes for capacitors And lithium ion.
3. In Biosensing and Bioimaging these graphene quantum dots are used widely.
4. Cancer Therapeutics and Drug delivery are the

Important areas where graphene quantum dots are used.

5. LED lighter convertors are manufactured with the help of graphene quantum dots.
6. Photo detectors are one of the application in which the graphene quantum dots are used.

IV. CONCLUSION

As we know as per the need of today's era, the methods we are listing and biproducts we make must be. Therefore, here in this it should be proper enough to be on that way. Hence in this review, the ecofriendly method which will be less toxic and more reliable with ecofriendly efficient work we are adopting, the GQDs have lot more advantage that can bare much more needs of today's issue related with health and technology.

It has quite more advantages out of which the less power consumption is the important one .There are several ways to synthesis the GQDs and they are easy, affordable. Nowadays, these technologies are demanding.

Some of the graphene quantum dots are reported to even posses up conversion photoluminescence properties attractive for multiphoton induced bio imaging. Therefore, the graphene quantum dots have attracted the tremendous attention for their wide advantages in bio0logical, optoelectric and energy related applications broadly in communication and energy functional devices in near future.

Here in this we summarised the various ways to synthesis the graphene quantum dots and their applications. These different methods show the general idea and the important applications of the graphene quantum dots. These are like bio sensing, drug delivery and several vital areas etc. Out of different methods, we are reviewing the chemical synthesis methods in different research work. These methods show the proper and desire results.

V. REFERENCES

[1]. J. Peng, W. Gao, Graphene quantum dots derived from carbon fibres, (Nano Letters), (2012) Rice University, United States

[2]. J. P. Naik, P. Sutradhar, Molecular scale rapid synthesis of graphene quantum dots (2017) DOI 10.1007/s40097-017-0222-9

[3]. S.H. Kang, S. Mhin, GQDs with highly efficient blue emission carbon fibres, (Scientific Reports), (2016) DOI: 10.1038/srep38423

[4]. M. K. Kumawat, M. Thakur Graphene quantum dots from Mangifera indica: application in near infrared bioimaging and intracellular nanothermometry, (ACS sustainable chemistry & engineering), (2016) DOI:10.1021/acssuschemeng. 6b01893