NANOMATERIALS FOR BIO APPPLICATION

PhD Research Proposal

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ABSTRACT

Nanotechnology has attracted a great deal of attention in the last few years as miniaturization and Nano materials are often foreseen to be the key for a sustainable future. Ina broadcast sense, Nano Science and nanotechnology makes use of the tools of synthetic and materials chemistry to generate Nanomaterials with size, shape and surface properties that can be designed to evoke a specific function with aim to be utilized in various potential applications. Nanotechnology allows us to manipulate the matter on a molecular scale (much less than 100 nm), helping us to obtain valuable information for the synthesis of new materials with specific properties and with a high degree of reproducibility. The proposed work mainly focuses on the green synthesis of carbon quantum dots using hydro thermal method. The nanomaterials will be characterised to study the structural and optical properties. The prepared nanomaterial will be used for bio medicine in Vivo and in Vitro bio-imaging, drug delivery.

INTRODUCTION

Carbon based quantum dots consisting of graphene dots(QGDS) and carbon quantum dots (CQDS, C – dots or CDs). or a new class of carbon nanomaterial with sizes below 10nm.The are first obtained during the purification of single walled carbon nanotubes through preparative electrophoresis in 2004. Carbon in commonly a black material and was generally considered to have a low solubility in water and weak fluorescence. Carbon based quantum dots have good solubility and strong luminescence. So they are referred as carbon nanolights. They are the best alternative to the semiconductor quantum dots.

PROPERTIES OF CARBON QUANTUM DOTS:

High stability, good conductivity, low toxicity and environmental friendly, CQDs have been extensively investigated especially due to their strong and tuneable fluorescence emission properties. Many carboxyl moieties on the CQDs surface impart excellent solubility in water, CQDs are suitable for chemical modification and surface passivation with various organic, polymeric, in organic (or) biological materials. CQDs have crystalline or amorphous structure, quasi spherical discrete carbon nanoparticle. The study of photo luminescence of such carbon dots at different temperature which helps to understand the luminescent mechanism of carbon dots.

SYSNTHESIS, SIZE CONTROL, MODIFICATION:

Many methods have been proposed to prepare CQDs during the last decade which can be roughly classified into” Top down “and “bottom up” and they can be modified during preparation are post treatment. Three problems facing CQDs preparation (1) carbonaceous aggregation during carbonization which can be avoid by using electro chemical synthesis, confined pyrolysis or solution chemistry methods. (2) Size

control and uniformity which is important for uniform properties and can be optimised via post treatment such as gel electrophoresis, centrifugation and dialysis. (3) Surface properties that are critical for solubility and selected applications which can be tuned during preparation or post treatment. Surface modification is a powerful method to tune surface properties. There are many approaches for functionalising the surface of CQDs through the surface chemistry or interaction, such as covalent bonding, coordination, π –π interaction and sol-gel technology. The majority of CQDs are rich in Oxygen containing groups, which endows them with feasibility in covalent bonding. Surface passivation via covalent bonding of amine containing agents is a common method to improve the PL of CQDs.

SCOPE OF STUDY:

Carbon quantum dots are used in many applications such as in bio medicine, bio sensor, bio drug delivery. In optronics such as dye sensitized solar cells, organic solar cells, super capacitors and light emitting diodes. Carbon quantum dots in biological labelling and in bio imaging have more potential application. CQDs can show a PL emission in the near infra-red (NIR)spectral region. Under NIR light excitation.

LIMITATION OF STUDY:

The CQDs have great potential in many applications but there are still some difficulties in the assembly of efficient and high quality and poor control over sizes.

REVIEW OF LITERATURE SURVEY:

Bui Thi Hoan. Et. Al (2019) in this article Green synthesis of highly luminescent quantum dots obtain from lemon juice by hydro thermal method. The ivory white solution of lemon juice was changed to dark brown solution indicated the formation of C dots. These solutions emitted green colour under ultra violet excitation. They demonstrated that the strong and stable green light emission of C- dots could be

synthesised successfully by one-part hydrothermal method. The PL intensity of C dots increase with increasing hydrothermal temperature and time. IN addition, C - dots diluted by polar solvents induced strong luminescence than did the pure C-Dots. The obtains carbon dots having strong, inert and stable luminescent properties would be particularly important for potential application in Optoelectronics and Bio engineering.

A.N.Kapitonov et al in this article the synthesised carbon dots from glucose,soot,juices of berries and citric acid. The photo luminescence of obtained carbon dots are investigated. All the samples exhibit excitation dependant emission. The photo luminescence intensity peaks are red shifted by approximately 70nm, with an excitation wavelength of 300 – 400 nm. CDs composite material changes the LED optical properties.

Nagamalai Vasimalai et al (2018) this article Green Synthesis of fluorescent carbon dots from spices such as cinnamon, red chillies, black pepper and turmeric. The C – dots synthesised using spices as starting material through a green one-pot hydro thermal method that involves pyrolysis, carbonization and passivation with no need to add surface passivation agents or any additives. The obtained carbon dots are characterised by UV- vis spectrometer and fluorescent spectroscopy. UV – vis spectra of each type of spice derived C- Dots reveal two absorption bands. Cinnamon C – Dots show characteristic absorption bands at 275 and 324 nm, red chilli C- Dots at 273 and 315 nm, Turmeric C-Dots at 282 and 329 nm, and black pepper C – Dots at 279 and 329 nm.

YouFu Wang et al (2014) this article carbon dots are synthesised from several methods chemical ablation, electro chemical carbonisation, Laser ablation, Microwave irradiation, Hydro thermal treatment. The CQDs were prepared via HTC from many precursors such as banana juice, glucose, citric acid and chitosan. The synthesised material were low toxicity but poor control over the sizes. In laser ablation, where the surface states are tunable but low quantum yield and poor control oversize. In electro chemical carbonization size and Nano structure are controllable and stable.

Pooria Namdari et al (2016) in this article the carbon quantum dots are synthesised by several methods, Chemical ablation, Electro chemical carbonisation, Laser

ablation, Microwave irradiation, Hydrothermal treatment and Optical properties were studied. In chemical ablation the quantum yield is 4.34 %. In Electro chemical carbonisation the quantum yield is 25.6 %. the size and Nano structure are controllable and stable. In Laser ablation low quantum yield and poor control over sizes. In microwave irradiation greenish yellow luminescent GQDs were obtained with the diameter of 4.5nm. The quantum yield is high 11.7 % to 22.9 %. This method is fast and scalable inexpensive. In Hydrothermal method the prepared dot possessed strong fluorescence with PL quantum yield as high as 11.4% and could be dissolved in water and most polar organic solvents without further chemical modification. The Nano size ranges from 5 – 13nm

METHODOLOGY:

Hydrothermal Technique

Hydrothermal synthesis is the one of the simplest, economical and wildly synthetic routes used to prepare CDs. This method has the advantages of cheap instrumentation, low energy consumption. Many research groups have also developed hydro thermal synthesis using green precursors such as beverage, fruit extract, food products and bio mass. By optimising the ratio of precursors, temperature and reaction time, CDs with homogenous size distribution and good florescence properties for obtain. The hydrothermal synthesis of CDs was carried out using Teflon lined autoclave. Mohapatra et al synthesised high photo luminescent CQDs with quantum yield of 26% in one step by HTC of Orange juice. Then they centrifuged resultant mixture. These carbon dots with sizes of 1.5 – 4.5 nm where used in bio imaging due to their low toxicity and high photo stability. A.N. KAPITONOV et al synthesised carbon Qdots from glucose, soot, juices of berries and citric acid using HTC. All the sample exhibit excitation-dependant emission. The photo luminescence intensity peaks are redshifted by 70nm, with an excitation wavelength of 300 – 400nm. These CDs composite material change the LEDs optical properties. Bui Thi Hoan et al synthesised high luminescent carbon quantum dots from lemon juice. They have high PL intensity used in Optoelectronics and bio

imaging.

REFERENCE:

Pooria Namdari, Babak Negahdari (2016) Synthesis, properties and bio medical application of carbon based quantum Dots.

YouFu Wang and Aiguo Hu (2014) carbon quantum dots: synthesis properties and application

A.N.Kapitonov, M.N.Egorova, Hydrothermal Synthesis of Carbon Dots and Their Luminescenece.

Nagamalai Vasimalai,Vania Vilas – Boas (2017) Green Synthesis of fluorescent carbon dots from spices for in vitro imaging and tumour cell growth inhibition.

Kok Ken Chan, Stephanic Hui Kit Yap (2018) Bio green Synthesis of Carbon dots for Biotechnology and Nano medicine Application.

Bui Thi Hoan,Phuong Dinh Tam (2018) Green Synthesis of Highly Luminenescent Carbon Quantum Dots from Lemon Juice

TIMELINE OF THE RESEARCH

Work Plan	Time
Literature review	3 months
Material selection	3 months
Optimization	6 months
Synthesis of CQDs	1 year
Characterization	6 months
Results and discussion	6 months