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Synthesis and Significance of Carbon Quantum Dots (A Review)

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History- CQDs were first discovered in 2004 accidently during the purification of single walled carbon nanotubes.[1]. Much progress has been achieved in the synthesis properties and application of CQDs.[2]

As a new class of fluorescent Carbon nanomaterial CQDs processes. The properties of high solubility good. Conductivity, low toxicity, environmental friendliness, simple synthetic route are well as comparable optical properties to quantum dots.[3]

Carbon quantum dots have been extensively investigated especially due to their strong and tunable fluorescence emission properties.

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I. Introduction

Carbon quantum dots are using semiconductor particles a few nanometers in size, having optical and electronic properties that after from larger LED particles.They are a Central theme in nano technology when the CQDs are illuminated by UV light; some of electrons receive enough energy to break free from the atom. This Capability allow them to more around the nanoparticle, \creating a conductance bond in which electrons are free to more through a material and conduct electricity. When these electrons drop back into the outer orbit around this atom they emit light. The colour of the light depends upon the energy difference between the conductance bond and the volume bond.Quantum dots are sometimes referred to as artificial atom, having properties. Intermediate between bulk semiconductors and discrete atom or molecules. Larger CQDs of 5-6 nanometer emit longer wavelength, with colors such as orange and red. Smaller CQDs (2-3). Emit shorter wavelength yielding odors like blue and green.Because of their highly tunable \properties CQDs of wide interest. Applications include transistors, solar cells, LEDs, Diode lasers and second. harmonic generation, quantum computing and medical imaging.[4]Their small size allows for CQDs to be suspended in solution, which may lead to use in inkjet printing and spin coating.[5]They have bun used in Langmuir - Blodgett this films.[6] [7] There has been remarkable progress in synthetic protocols for fabrication of fluorescent C-dots in past few years widely used among them is microwave irradiated synthesis, laser ablation of graphite[8] thermal cracking of carbonaceous materials[9] electro oxidation of graphite[10] and oxidation of shoot.Recently CQDs has been synthesized using orange juice and commercially available as they contain carbohydrate.

II. Method of Synthesis

Thomas Nesakumar in chemical and electrochemical methods have been employed for the synthesis of CQDs. Many Carbon precursor including Carbohydrate.Ascorbic acid, citric acid, tannic acid and organic sources have been utilized for the synthesis CQDs through the hydrothermal method.Kumud Malika Tripathi in (2016) give a synthesis of Carbon dots from lemon peel waste dry lemon peels were crushed and put into. Solution of H_2SO_4 then washed then kept in sodium hypo chloride solution. Then this solution allowed to cool at room temp. Sample was crushed and centrifuged and 10000 rpm and CQDs are finally dried at 100^oC[9] Xiangcheng Sun, Yu Lei suggest that Carbon dots through soot which was derived from combustion of unscented candles. Acid reflux, Centrifugation, electrophoresis of the collected soot could achieve small (<2mm) water soluble. Carbon dots with different emission colours.Green Synthesis of carbon nanodots from cotton has been developed by xiengping Wen. CQDs were synthesized by pyrolysis of cotton in a typical into a muffle furance, and was pyrolysed at 300^oC for 2 hrs. After cooling down to room temp, the CQDs were collected by room temp the CQDs were collected by removing larger particles though centrifugation at 400 rpm for 10 min. The obtained CQDs was treated in a domestic microwave oven (700W) Fungus derived photo luminescent carbon nanodots for detection of Hg^{2+}ions by Sada Venkateshvarlu. Edible mushroom were collected. Then cut the appropriate volume and transferred to a Teflon - lined stainless steel heated at 170^oC for 3 hrs and cool at room temp. A dark brown solution was obtained and separated from centrifugation then powder form of CQDs were obtained by freeze drying. Vikram Sing and Ashok Ku Mishra suggested white light emission from a mixture of pomegranate extract and Carbon nanoparticles obtained from the extract. White light emission produced upon 380 mm photo oxidation from 9 mixture of pomegranate and carbon nanoparticles made from the extract in aqueous acidic (pH-1-2) solution as well as in polyemyle alcohol polymeric film with good commission. International Del Eclairage (CIE) Index value (028-02.33) and (0.33-0.29) respectively. The fluorescent Carbon nanoparticles were prepared by hydrothermal treatment of pomegranate extract in a very simple green and cost effective way.[10] P.P.N. Vijay Kumar suggested green synthesis of copper oxide, Nanoparticles using. Aloe vera leaf. Extract and its

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antibacterial activity against fish bacterial pathogens. Green synthesis of Cuo nanoparticles by using eco-friendly and non toxic Aloe vera leaf extract. X-ray diffraction and (TEM) analysis revealed that synthesized Cuo nanoparticles are monoclinic phase with average particle size of 20mm. Antibacterial activity of green synthesized Cuo nanoparticles was tested against three bacteria fish pathogens which are responsible for causing severe infections diseases in fishes. Cuo NPs exhibits enhanced antibacterial activity against all the fish pathogens even at lower Concentrations above 20mg/ml.[11] [12] Amit Kumar, Angshuman Raj Choudhary suggested Green synthesis of Carbon dots from ocimum sanctum (Tulsi) for effective fluorescent sensing of pb^{+2} ions and live cell imaging. The synthesized CQDs possess high stability in aqueous solution and exhibit strong fluorescent with Quantum yield of 93% and fluorescent for pb^{2+} ions detection. Limit of detection (LOD) of pb^{2+}ions is 0.59 mm. The pb^{2+} ions are also detected in triple negative breast cencer cells (MDA-MB 468 cells) and real water samples.[13] Adhimoorthy Prasannan, suggest a simple and facile are step synthesis of fluorescent carbon dots from orange waste pulps was performed using the hydrothermal Carbonization method at a mild temp (180^oC) The chemical Composition and morphological feature of the obtained C-dots were characterized using various spectroscopes. The prepared hydrothermal carbon were among our in nature and clusters of polychromatic hydrocarbon included a large quantity at oxygen functional groups. A composite of C-dots with Zno was used as a phatocatlyst for degradation of napthol blue-black 930 dye under UV iriadiation and the superior photo catalytic activity was demonstrated. The present preparation method of CQDs takes on meaning in the area of green.

III. Significance of Carbon Quantum dots

Swagatika Sahu, Sasmita Mohapatra gave significance that highly photoluminiescent carbon dots with a PL quantum yield of 26% have been prepared in one step by hydrothermal treatment of orange juice. Due to high photostability and low toxicity these Carbon dots are demonstrated as excellent probes in cellular imaging.[14] [15]

Biocompatible carbon dots synthesized from yogurt via microwave synthesis successfully used in imaging of calon epithelial calls. Toxicological assessment of yogurt carbon dots showed no toxic effects on healthy Con cells and MCF-7 breast cencer cell upto 7.1 mg/ml. carbon dots concentration.[16] Fluorescent Carbon dots synthesized from pomegranate fruits using hydrothermal method were using in bio imaging of pseudomonas arranginosa and tusarlum (Kasibaku at al 2ds) [17] Habs at al (2016) produced Carbon dots from citric acid and glucosamine using domestic pressure cooker, Resulting.Carbon dots with bright, stable and wavelength dependent fluorescence were utilized in imaging of mice embryonic fibroblast cell with almost no cytotoxic effort up to 0.667 mg/mm. Carbon dot concentration. (Labor at al 2016).[18] Atchudan at al (2017) reported a utilization of nitrogen dopped Carbon dots from chinomonthus returns fruit extract as a biological probe for investigation of candida albicans and Cryptococcus neoformans strains in fluorescent microscope.[14] Orange juice was used as a natural precursor in synthesis of Carbon nanoparticles by Sahu at al (2012).Strong fluorescent Carbon dots showed no cytotoxicity on osteosarcoma MG-63 cells and were efficiently taken up by these cells.[20] Yang et al 2014 Carbon dots originated from honey exhibited successful performance in sensitive and selective detection of Fe^{3+}. [21] Yu et al (2015) described the green, low cost, water soluble fluorescent Carbon, dots preparation of Carbon dots from Jinhua via hydrothermal method. The prepared Carbon dots were successfully used in detection of Hg^{2+} and Fe^{3+}. [22] Dine (2016) extracted Carbon dots from sugar been molasses without using any additional process extracted Carbon dots exhibited strong blue florescence under UV light. These Carbon dots were used as a sensing probe for detection of riboflavin and tetracylin. [23] Wang et al (2016) reported a simple one step hydrothermal green approach to prepare Carbon dots from papaya powder. As prepared Carbon dots were used as a potential probe for fluorescence sensing of E. Coli 0157\: H7 [24] Majumdar et al (2018) Carbon dots synthesized from chitosan and functionalized with sodium fluoride can selectively detect retionoic acids.[25] Carbon dots prepared by pyrolysis of leaves (Palm, Bamboo, Camphor, Ginks etc.) were used as a fluorescent sensing platform for fe^{3+} detection (Zhu et al 2013).[26] Orange peel derived fluorescent Carbon dots loaded with ZNO obtained using hydrothermal Carbonization method were used as a photocatalyst for degradation of napthol blue black 930 dye under UV irrediation (Prasannam 2013).[27]

Conclusion

Carbon dots are rising stars of Carbon nanomaterials. In this mani-review, we summarized the synthesis and applications of Carbon dots derived from natural and food sources. Notably, Synthesis method of carbon dots are simple green and low cost.

Besides, application of Carbon dots is various including medicinal, sensor, solar cells. Computer conductors, Bio-imaging, drug delivery etc.

We think that synthesis methods and applications area of Carbon dots are increasingly developing. Therefore, we aimed draw attention to Carbon dots, to encourage future studies in this paper

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