Carbon quantum dot synthesis from indigo plant (*Indigofera tinctoria* .L)

Abstract

One of the main challenges of making an electrochemical sensor is the selection and preparation of appropriate modifying materials for the electrodes. So far, many studies have been done to modify electrodes using nanostructures in order to improve the performance of sensors. Meanwhile, carbon nanomaterials have been widely used due to their high sensitivity, selectivity and stability. Among others, we can mention carbon quantum dots, quantum graphene dots and Nano composites of carbon nanotubes and carbon Nano fibers. Our goal in this research is to prepare quantum dot carbon using natural resources such as indigo plant with a hydrothermal method. The structure and characteristics of the synthesized material were investigated using analyzes such as FT-IR, Uv-Vis, etc.

Keywords: Green, synthesis, carbon quantum dots Indigo plant

Introduction

CQDs are a new class of carbon nanomaterial's with dimensions less than 10 nm, which were obtained for the first time during the purification of single-walled CNTs through primary electrophoresis in 2004[1]. Among carbon materials, CQDs are considered as a new generation material with excellent electron transfer capability, a suitable alternative to other carbon competitors. CQDs offer a high potential to replace traditional semiconductor quantum dots due to their unique luminescence performance, smaller size, good solubility, biocompatibility, increased adsorption capacity of reactive substrates, and low toxicity. Also, these compounds have many applications in the development of biological imaging, medical diagnosis, catalysis, etc. CQDs can be prepared from natural materials such as fresh mint leaves banana peel scraps, etc. The indigo plant belongs to the legume family and its original habitat was India. Indigo root and stem, bitter taste and laxative effect[2].

It has expectorant and anti-parasite worms and strengthens hair. All parts of this plant reduce inflammation have and use them to treat chronic bronchitis, asthma (especially in children), hemorrhoids, insect bites and poisonous reptiles, It is used to treat wounds and skin disorders, in terms of the chemical compounds in the plant, including endical substances, endoxyl, There is isatan and labenzim, and the color extracted from this plant in ancient civilizations,

such as Mesopotamia, Egypt, Greece, Rome, England, Central America, Peru, Iran and Africa have been known[2]. The study aimed to green synthesize of carbon quantum dots from a native plant called Indigo or Indigo with the scientific name Indigofera Tinctoria L. Indigo is a medicinal-industrial plant belonging to the legume family, which is cultivated in the south of Iran (Shoushtar)[3]. The components of Indigo plant are: alkaloids, glycosides, flavonoids, tannins, and phenolic compounds, amino acids, carbohydrates, mineral compounds, other compounds such as ash, ash soluble in acid, ash soluble in water, etc. Our goal in this research is to prepare quantum dot carbon using natural resources such as indigo plant with a hydrothermal method[4].

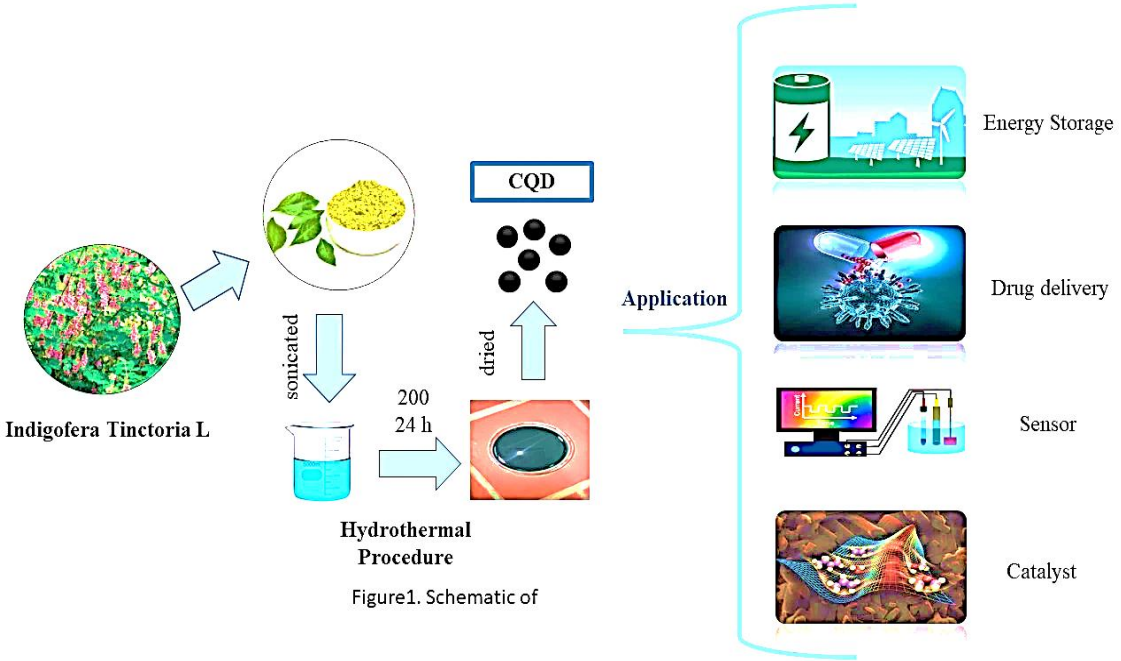
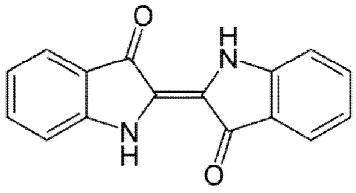


Figure1. Schematic of



indigo

Experimental

In this study, carbon quantum dot was synthesized by a hydrothermal method from Indigo as precursors in deionized water at 200 °C for 14 h.The sample was dried in an oil bath and

washed three times with ethanol. Finally, the resulting black powder was dried in a vacuum oven for 6 hours.

Results & Discussion

Figure2. presents the FT-IR spectrum of the CQD. The broad peak at 3357 cm^{-1} confirms the stretching vibration of the O-H bond of the acidic and alcoholic functional group. The peak at 2931 cm^{-1} shows the stretching vibration of the C-H bond of SP^3. At 2364cm^{-1} C-H SP^2 stretching vibration of benzene ring of carbon dot structure and at 1591cm-1 N-H bending vibration is confirmed. The peak at 1416cm^{-1} O-H bending vibration is related to acidic and alcoholic functional groups. The two peaks at 1650cm^{-1} and 1078cm^{-1} show the stretching vibration of C=C and C-O, respectively. The peaks in the area of 672-751cm^{-1} show the bending vibration of C=C.

Figure 3 shows the uv-vis analysis of the sample in the range of 190-400nm in water solution. The peak in the region of 210 nm represents the electron transfer π to π^* of C=C double bonds and the peak at 250 nm represents the n to π^* electron transfer caused by the pair of non-bonding electrons of nitrogen or oxygen.

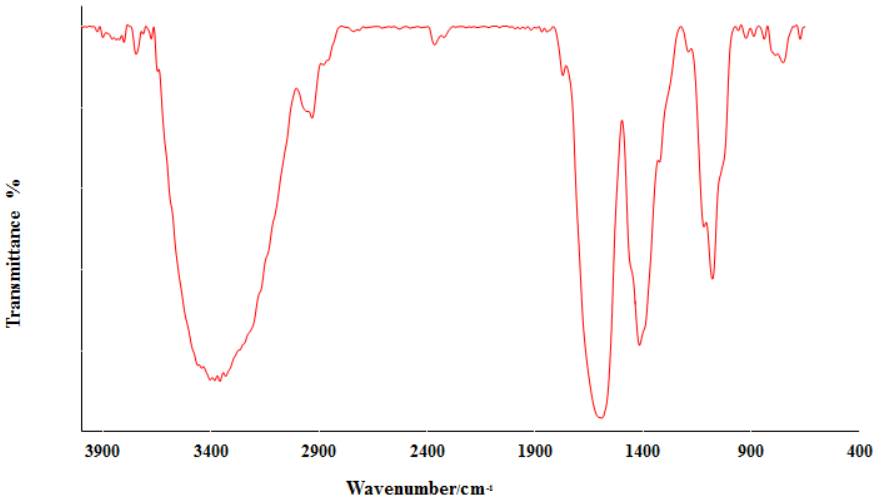


Fig 2. FT-IR of prepared sample

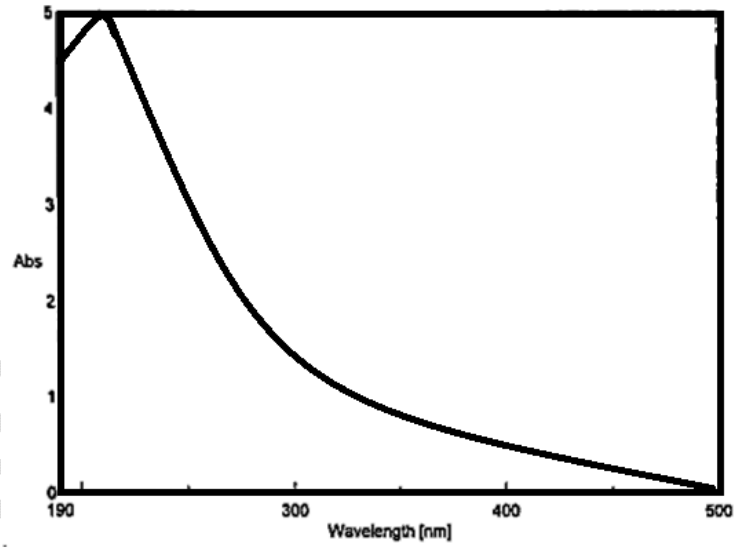


Figure 3. Uv-Vis of sample

Conclusion

Considering the importance of using carbon materials to modify the electrode surface and the features mentioned for carbon quantum dot, we prepared carbon quantum dot using indigo plant and with a hydrothermal method. Carbon quantum dot prepared by methods such as IR and UV. etc. We identified and checked. The synthesized material can be used to modify the electrode surface in sensing applications, corrosion, etc. This work can be a model for preparing carbon quantum dots from other natural sources.

References

- R.M. Shereema, T.P. Rao, V.S. Kumar, T.V. Sruthi, R. Vishnu, G.R. Prabhu and S.S. Shankar, Materials Science and Engineering: C, 2018 , 93, 21.
- M. Algarra, A. González-Calabuig, K. Radotić, D. Mutavdzic, C.O. Ania, J.M. Lázaro-Martínez, J. Jimenez-Jimenez, E. Rodríguez-Castellón and M. Del Valle, Talanta, 2018, 178, 679.
- M.R. Zargaran Khouzani, Central Asian Journal of Environmental Science and Technology Innovation, 2022, 3, 32.
- M.R. Zargaran Khouzani, A.R. Siahpoosh and M.A. Daei Naseri, The first national conference on the application of modern chemical and agricultural researches in the development of medicinal plants, 2021, 37.
- M. Moalem-Banhangi, N. Ghaeni and S. Ghasemi, Synthetic Metals, 2021, 271, 116626.