

Opponent's Assessment of the Dissertation

Workplace: **Centre of Polymer Systems, TBU in Zlin**

Academic year: **2023/2024**

Student: **R. Blessy Pricilla, M.Sc.**

Doctoral degree program: **Nanotechnology and Advanced Materials**

Study course: **Nanotechnology and Advanced Materials**

Supervisor: **prof. Ing. et Ing. Ivo Kuřitka, Ph.D. et Ph.D.**

Reviewer: **doc. Ing. Marián Lehocký, Ph.D.**

Doctoral thesis title: Preparation and characterization of carbon dots for versatile applications

Introduction:

The submitted work by R. Blessy Pricilla deals with the preparation and characterization of carbon dots.

In this thesis, various carbon dots have been obtained by exploring multiple precursor categories: Proteins, Biomass, and organic. The precursors used are non-toxic and free of rare earth elements and metals, making the prepared carbon dots environmentally friendly and independent of problematic sources. Different synthesis methods, such as microwave, hydrothermal, and heating, were utilized to obtain a reasonably high yield.

Therefore, the topic of the thesis can be considered highly relevant and, for many reasons, socially beneficial.

Achievement of Stated Objectives:

This dissertation aims to develop a new category of multifunctional carbon dots by leveraging readily available and abundant source materials through straightforward and efficient production methods. The primary focus of the study is on the fluorescence and phosphorescence properties of the prepared carbon dots, with in-depth exploration and anticipated applicability demonstrations. Additionally, other functionalities, such as antimicrobial activity, are investigated based on the recently identified characteristics of the prepared materials. All set objectives have been successfully achieved.

Problem-solving Approach and Dissertation Results:

The problem-solving process occurred in several logical steps that sequentially built upon each other.

1. **Source selection:** The source material should be green and sustainable. Proteins, biomass, and organic precursors are explored.
2. **The choice of the method:** A quick and controllable synthesis method should be used, facilitating fast and scalable production.

3. **Characterization:** Morphology is examined using TEM; structure is analysed through XRD, FTIR, XPS; electronic properties are assessed using PL and UV-Vis. An analysis of their structure, properties, and luminescence mechanism are conducted.
4. **Exploration of application potential:** The prepared carbon dots are investigated for various applications, including anticounterfeit measures, sensing, phosphor for LEDs, antibacterial properties, security, etc.
5. **Publication in renowned journals:** This process can be characterized as appropriate and reasonably well thought out.

The significant outcomes of the doctoral study can be seen in obtaining valuable and interesting data with the potential to introduce new approaches to the studied issue. It is noteworthy that the study has resulted in the creation of three publications, with R. Blessy Pricilla as the first author. Two of these articles have already been published. Also significant is the participation in two congresses where the results were presented.

Significance for Practice or Field Development:

The presented data contribute to a fundamental understanding in the field of applications for the prepared carbon dots, aiming to achieve multifunctional nanomaterial. Examples demonstrating this include anticounterfeit applications, LEDs, sensors, antibacterial applications, information encryption, and more. Therefore, the dissertation and its results are intriguing from both a scientific and societal perspective.

Formal Presentation and Language Quality:

The text is written with high expertise, addressing current issues and limitations in the field. It is well-structured, easy to read, and effectively uses technical terminology. The citation of 153 original literary sources, particularly recent literature, demonstrates thorough research. The formal presentation, including graphical elements, is of high quality. The language level is also commendable.

Overall Evaluation:

The dissertation is very well prepared, meeting all requirements. Minor issues do not diminish the overall quality of the work. R. Blessy Pricilla's capabilities are evident, and she has demonstrated maturity and proficiency in her field.

Suggestions:

I have no significant comments regarding the work, perhaps only a few details that should be addressed differently. Firstly, there is an inconsistent format of table borders. For example, tables 1, 2, and 7 differ in this regard. Furthermore, abbreviations and symbols in the list of abbreviations and symbols should be sorted alphabetically. Additionally, the name of the plant "*Syzygium cumini* L." in the heading of chapter 5.2.2 should be in italics, as in the heading of chapter 5.2. The same issue occurs within chapter 7, 7.5, and 9.1 (line 7). The list of abbreviations and symbols is also incomplete, as abbreviations used in Fig. 10 and in the text description are missing.

Questions:

As part of the discussion, I would like to ask a few questions:

- Page 60: which of the studied ions has the most interesting and applicable photoluminescence response?
- Fig. 20 (B): How do you explain pH influence on photoluminescence response?
- Fig. 21: Are there another available methods for particle size evaluation? Explain their principles.

Conclusion:

In conclusion, I note that the student has demonstrated creative abilities in the given research area, and the thesis meets the standard requirements commonly set for dissertations in the respective field. Therefore:

I recommend R. Blessy Pricilla's dissertation for defense and the conferment of the "doctor" (Ph.D.) academic title.

In Zlín, 8 January, 2024...

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doc. Ing. Marián Lehocký, Ph.D.