

REVIEW

on the defense of a dissertation on the topic "Electrospun hybrid materials based on poly(L-lactide-*co*-D,L-lactide) and chitosan derivatives with purposely tailored design for potential biomedical applications and photocatalytic water purification"

by doctoral student **Ina Borislavova Anastasova**

submitted for acquisition of the educational and scientific degree "Doctor" Professional field:
4.2. Chemical Sciences, Specialty: Polymers and Polymer Materials

Reviewer: Prof. Mariana Argirova, DSc

Department of Chemical Sciences, Faculty of Pharmacy, Medical University of Plovdiv

By Order No. PD-09-182 of December 2, 2025 of the Director of the Institute of Polymers (IP) of the Bulgarian Academy of Sciences (BAS), I am appointed as a member of a scientific jury that must to render a decision on awarding the scientific degree "Doctor" to Assist. Prof. **Ina Borislavova Anastasova**, a full-time doctoral student in the Laboratory "Biologically Active Polymers" at the IP. At the first meeting of the scientific jury, held on December 15, 2025, I was assigned to prepare a review on the procedure for awarding the scientific degree.

The review was prepared in accordance with the Development of the Academic Staff in the Republic of Bulgaria Act (DASRBA), the Regulations for its implementation, the Regulations of the BAS and the Regulations established in the IP of the BAS for the implementation of the aforementioned act. The doctoral student's dissertation was discussed at a colloquium of the Institute, held on November 21, 2025. All necessary materials for the preparation of this review were provided to me in electronic format.

1. Biographical information about the candidate

Ina Borislavova Anastasova is a graduate of the Faculty of Chemistry and Pharmacy of Sofia University "St. Kliment Ohridski", where in 2021 she received a master's degree in "Modern Spectral and Chromatographic Methods of Analysis". The same year she began full-time doctoral studies in the Laboratory of Biologically Active Polymers of the IP under the supervision of Prof. Dr. Olya Stoilova and Prof. Dr. Milena Ignatova. She successfully passed the exam in the specialty "Polymers and Polymer Materials" with excellent results, as well as the exams on several closely specialized topics that are part of the training of doctoral students. She is a co-author of 3 scientific papers published in journals with an impact factor and one utility model. Assist. Prof. Ina Anastasova is a participant in two scientific projects with

European funding. In March 2025 she was awarded the "Prof. Ivan Shopov" award for an outstanding young scientist in the field of polymers.

2. Assessment of the scientific and research accomplishments of the candidate

2.1. Assessment to meet the minimal criteria in accordance with Specific the Rules for Granting Academic Degrees set at the Institute of Polymers, Bulgarian Academy of Sciences, Application 1.

In preparing the dissertation, the doctoral student has complied with the requirements of Art. 29 and 30 of the Regulations on the terms and conditions for acquiring scientific degrees and for occupying academic positions in the IP at the Bulgarian Academy of Sciences. The content of the dissertation is included in two scientific articles published in a journal with an impact factor and ranked into the first quartile of journals in the field of polymer chemistry. In this way, the doctoral student collects a total of 100 points with the required 80 from the above-mentioned regulations and Appendix 1.

2.2. Assessment of the requirement for the doctoral thesis to contain valuable theoretical or applied science results that correspond to modern achievements and represent a significant and original contribution to polymer science.

The dissertation has a classical structure and a good balance between the individual parts: literature review, goal and objectives, results and discussion, experimental part and cited literature (323 sources).

The analytically presented literature review contributes for a very well-argued formulation of the goal and objectives of the dissertation. It sets a clear goal: to obtain and characterize electrospun hybrid materials from poly(L-lactide-co-D,L-lactide) and chitosan derivatives with a purposely tailored design and to demonstrate some potential applications in biomedicine and for photocatalytic water purification. This goal is well justified by the doctoral student and is a continuation of the many years of fruitful research of the laboratory in which she works.

In the literature review, Ina Anastasova outlines the advantages of hybrid materials from biodegradable polymers, the advantages of electrospinning as a method that allows the production of fibrous polymers with a large specific surface area and a fine porous structure (so-called mats). The use of hybrids of two biodegradable polymers – polylactide and chitosan is justified from the point of view of obtaining electrospun materials with desired composition, morphology and properties. The possibility of chemical modifications of chitosan is considered, which purposefully allow the manifestation of specific properties of the polymer materials in which it is included. The doctoral student applies two chemical modifications:

- Formation of aldimine (so-called Schiff base) between amino groups of chitosan and 8-oxyquinoline-2-carbaldehyde. The carbonyl component was chosen

purposefully, taking into account the good antimicrobial and chelating properties of 8-oxyquinoline.

- Preparation of quaternary ammonium salts of chitosan, which impart an electrical charge to the polymeric material and increase its solubility in a wide pH range, enhance its antibacterial activity and improve adhesion to negatively charged surfaces. These new functional properties allow for potential applications of quaternized chitosan both in medicine and for environmental protection.

Undoubtedly, the dissertation contains new scientific results that represent a significant and original contribution to polymer science and have plausible possibilities for practical application.

2.3. Assessment of the scientific accomplishments of the candidates covering the merits to the fundamental and applied research, as well as to the relevance of the topic. The assessment also includes the personal contribution of the applicant

Actuality of the chosen topic of the dissertation is undisputed, as biopolymers are among the most promising materials that could replace conventional plastics, the widespread use of which leads to the accumulation of waste and pollution of soil, water and atmosphere.

For the first time, hybrid fibrous materials from polylactide and the Schiff base of chitosan with 8-oxyquinoline-2-carbaldehyde were obtained by electrospinning. Their functionality was purposefully increased by synthesizing coordination chelates with the biologically significant Cu^{2+} and Fe^{3+} ions. By comparison with appropriate controls (chitosan and chitosan with bound 8-oxyquinoline), it was proven that the binding of metal ions to the polymer matrix gave the fibrous materials bactericidal activity and a pronounced antiproliferative effect against two tumor cell lines, which emphasizes the importance of the applied chemical changes for the manifestation of the desired biological properties. The results obtained were analyzed with appropriate statistical methods.

Quaternized N,N,N-trimethyl chitosan iodide was chosen as an adhesion agent for ZnO nanoparticles on polylactide fibers. By simultaneously combining two methods: electrospinning and electrospaying, two types of materials containing ZnO and Fe_3O_4 were obtained. Due to the incorporated iron oxide, the polymeric materials exhibit magnetic properties. Studies on the photocatalytic decomposition of the dye methylene blue show that the photocatalytic activity of ZnO deposited on the fiber surface significantly exceeds its independent photocatalytic activity.

The studied physicochemical and photochemical properties of the obtained electrospun hybrid materials including ZnO and Fe_3O_4 demonstrate high potential for application as ecological filtration membranes. They also show good free radical scavenging ability against DPPH radical.

2.4. Assessments of the scientific production of the candidate as well as the reflection of the results in the works of other authors.

The content of the dissertation work is involved in two scientific articles published in the journal **Polymers**, which in the years of publication has an impact factor of 5.0 (2022) and 4.9 (2024), respectively. At the time of presentation of the dissertation, the article describing the preparation and properties of the hybrid material polylactide-chitosan, modified as a Schiff base (2022), has been cited 13 times in journals referenced in international databases of scientific literature; the article on the photocatalytic properties of a hybrid containing quaternized chitosan (2024) has been cited once.

The results of the doctoral student's research have been presented to the scientific society at 15 national and international conferences.

3. Assessment of the qualities of the extended abstract of the doctoral thesis, whether it correctly reflects the contributions of the doctoral thesis.

The abstract follows the content of the peer-reviewed dissertation in a condensed form and in a volume of 44 pages presents the set goal and tasks, the own results obtained and an adequate discussion on them, emphasizing the novelties in the conducted research, the conclusions drawn and contributions of the dissertation. The abstract is illustrated with figures from the dissertation, which are individually numbered. The bibliographic data of the two publications on the dissertation and the scientific forums at which the results of the research were presented are also included.

4. Opinions, notes and recommendations.

The dissertation is written in a very good scientific language, concisely, follows the logical sequence of the experiments and their interpretation, which makes it very convincing. Its graphic design is impeccable. The doctoral student work impresses with the many methods mastered and a significant amount of data, presented in 35 figures and 2 schemes. My only note is regarding the use of the term "UV light", since light is only that part of the electromagnetic spectrum that is perceived by the human eye.

I have no personal impressions of doctoral student but I know well the style, precision and productivity of the Laboratory of Bioactive Polymers and I am confident that the spirit of the team in which Iva Anastasova works has managed to educate an ambitious and searching young scientist. This is also evidenced by the fact that at the end of the dissertation she outlines the directions for her future research

5. Conclusion.

The content of the dissertation convincingly shows that the doctoral student Ina Borislavova Anastasova has not only built on the knowledge obtained in the master's degree and has covered the educational component of the "Doctor" degree, but also possesses in-depth

theoretical knowledge and professional skills in the field of polymer chemistry, has mastered a number of instrumental methods for studying polymer materials, shows analytical skills in interpreting data and is able to present her results in a reasoned manner.

After reviewing the documents submitted by the candidate and the analysis of the significance of the research conducted, the submitted dissertation thesis and the publications presented, I confidently give my positive assessment and recommend to the esteemed members of the scientific jury to award **Ina Borislavova Anastasova** the educational and scientific degree "Doctor" in the professional field 4.2. Chemical Sciences, scientific specialty "Polymers and Polymer Materials".

January 21, 2026

Reviewer: