REVIEW

by Vesela Tsvetanova Tsakova-Stancheva, DSc,

Prof. at the Institute of Physical Chemistry, Bulgarian Academy of Sciences

(surname, first name, middle name, academic position at the higher education institution or scientific organization)

regarding the materials submitted for participation in the competition

for the academic position of "**professor**"

at Plovdiv University "Paisii Hilendarski",

in: field of higher education 4. Natural sciences, mathematics, and informatics

professional field. 4.2. Chemical sciences (Physical Chemistry).

In the competition for "professor" announced in the State Gazette, issue 96 of 11.11. 2025, and on the website of Plovdiv University "Paisii Hilendarski" for the needs of the Department of Physical Chemistry at the Faculty of Chemistry, Assoc. Prof. Nina Dimitrova Dimcheva, PhD, from Plovdiv University "Paisii Hilendarski" is participating as a candidate.

1. General presentation of the materials received

By Order No. РД-22-52 of 09.01.2026 of the Rector of Plovdiv University "Paisii Hilendarski", I have been appointed as a member of the scientific jury in a competition for the academic position of "professor" at PU in the field of higher education 4. Natural Sciences, Mathematics, and Informatics, professional field 4.2. Chemical Sciences (Physical Chemistry), announced for the needs of the Department of Physical Chemistry at the Faculty of Chemistry.

Assoc. Prof. Nina Dimitrova Dimcheva, PhD, from Plovdiv University "Paisii Hilendarski" has been admitted to participate in the announced competition.

The set of materials submitted by Assoc. Prof. Nina Dimitrova Dimcheva on paper and electronic media is in accordance with the Regulations for the Development of Academic Staff at Plovdiv University and includes the following documents:

1. Standard application to the Rector for admission to the competition;
2. Curriculum vitae in European format;
3. Diploma of higher education with acquired educational and qualification degree "Master" with appendix;
4. Diploma of educational and scientific degree "Doctor";
5. Diploma (certificate) for the academic position of "associate professor";
6. List of scientific works;
7. Scientific works (copies of publications);
8. Certificate of compliance with the minimum national and additional faculty requirements;
9. Declaration of originality and authenticity
10. Abstracts of materials under Article 76 of the Regulations for Academic Staff (in Bulgarian and English);
11. Self-assessment of contributions (in Bulgarian and English);
12. List of citations;
13. Document (certificate) of work experience;
14. Documents for teaching work: reports on classroom and extracurricular activities, list of teaching aids;
15. Documents for research activity – certificates for participation in research projects and patents for inventions;
16. Documents in accordance with the additional requirements of the respective faculty – reference for fulfillment of the additional requirements of the Faculty of Chemistry;
17. Other documents – certificates for work with the National Science Fund and for reviewing articles for scientific journals.
18. Set of documents on paper from items 1 to 20 – 2 copies.
19. Set of documents on electronic media from items 1 to 20 – 2 copies.

The candidate, Assoc. Prof. Nina Dimitrova Dimcheva, has submitted a total of 45 scientific works, including 40 scientific publications, two book chapters, two textbooks, and one patent. All scientific works are in the professional field of the competition, have not been used for the defense of her PhD thesis or in the competition for associate professor, and are accepted for review with the exception of publication [37]. The latter was printed in conference materials (AIP Conference Proceedings, 2803(1), (2023), 040014), but is presented only as a summary in the competition materials. The distribution of scientific works by relevant categories, in Bulgaria and abroad, is as follows: 29 publications and two book chapters printed

in foreign editions, ten scientific publications and two textbooks printed by Bulgarian publishers. A document for a patent for invention, published in the official bulletin of the Patent Office of the Republic of Bulgaria, is also presented.

2. Brief biographical information

Nina Dimcheva graduated from a mathematics high school in Plovdiv. She received her higher education at the Faculty of Chemistry of Sofia University "St. Kliment Ohridski," graduating in 1990 with a specialization in "Theoretical Chemistry and Chemical Physics." From 1993 to 2006, she was successively an assistant, senior assistant, and chief assistant at the Faculty of Chemistry of Plovdiv University. In 2001, she received her PhD in Physical Chemistry. Since 2006, Nina Dimcheva has been an associate professor at Plovdiv University. Since 2018, she has been the head of the Department of Physical Chemistry. From 2021 to 2025, she is a member of the Permanent Scientific Expert Commission on Chemical Sciences at the National Science Fund of Bulgaria.

She has two specializations abroad, in the groups of world-renowned electrochemists: in 2002-2003 at Lund University, Sweden, in the group of Prof. Lo Gorton, and in 2007-2008 at the Ruhr University, Bochum, Germany, in the group of Prof. Wolfgang Schumann.

Assoc. Prof. Dimcheva's teaching activities include five lecture courses in Physical Chemistry, Electrochemical Methods of Analysis, and Biocatalysis and Bioelectrochemistry, as well as conducting exercises and seminars in the same disciplines for students at different stages of their education.

In her scientific career to date, Assoc. Prof. Dimcheva has been the supervisor and co-supervisor of four successfully defended doctoral students, and currently supervises the work of one regular doctoral student. She has participated as a contractor in a total of six research projects, including three large projects funded by EU regional funds with Bulgarian co-financing, two projects funded by the National Science Fund, and one project supported by the Scientific Research Fund of Plovdiv University. She has been the leader of two projects funded by the National Science Fund on the topics: 1) "Bioelectrochemical methods for rapid, selective, and sensitive control of food quality and safety based on nature-friendly interdisciplinary research (FOQUS)" and 2) "Chemo-enzymatic catalysis in non-aqueous media (ChEnCat)".

3. General description of the candidate's activities

Assoc. Prof. Nina Dimcheva is intensively involved in teaching and educational activities at the Faculty of Chemistry of Plovdiv University. Since 2019, she has taught the following courses: "Physical Chemistry," Parts I and II – a lecture course for students majoring in Bachelor's degrees Chemistry, Medical Chemistry, Chemical Analysis and Quality Control (Analysis and Control), Chemistry with Marketing, and Computational Chemistry; "Physical Chemistry," Parts I and II – lecture course for students majoring in Chemistry and Physics, Biology and Chemistry, and Chemistry and English; "Physical Chemistry" – lecture course for students majoring in Biology and Molecular Biology; "Electrochemical Methods of Analysis" – compulsory lecture course for students in the bachelor's program in Analysis and Control/Chemical Analysis and Quality Control; "Biocatalysis and Bioelectrochemistry" – a specialized lecture course offered as an elective subject for the majors in Chemistry, Medical Chemistry, Analysis and Control, Chemistry with Marketing, Biology and Chemistry. The total number of lecture hours for the last seven academic years is 1,018. In these disciplines, Assoc. Prof. Dimcheva has also conducted laboratory exercises (a total of 391 hours) and seminars (a total of 75 hours). According to the summary information on the number of classroom hours, equivalent to exercises, the total workload for seven academic years is 2,504 academic hours. In this respect, the candidate significantly exceeds the additional requirements for the position of "professor" at Plovdiv University, namely to have conducted no less than 1,800 hours of classroom lectures with students, of which no less than 150 hours lectures in the discipline (Physical Chemistry) for which the competition is announced.

To support the preparation of students in the subjects taught, the candidate has co-authored two textbooks:

(a) "Exercises and Tasks in Applied Physical Chemistry," Plovdiv University Press, Plovdiv, 2007, intended for students enrolled in the master's program in Applied Physical Chemistry. In the section "Biocatalysis and Electrocatalysis," ten laboratory exercises were developed in collaboration with Assoc. Prof. E. Horozova, PhD.

(b) "Guide to Laboratory Exercises in Physical Chemistry and Colloid Chemistry" (2nd revised and expanded edition), University Press "P. Hilendarski", Plovdiv, 2017, intended for students from all bachelor's degree programs at the Faculty of Chemistry and for the Biology

and Chemistry program at the Faculty of Biology at Plovdiv University; the candidate is the author of four laboratory exercises.

Assoc. Prof. Dimcheva has also developed three curricula, approved by the Faculty Council of the Faculty of Chemistry, as follows:

(a) "Electrochemical Methods of Analysis" – a specialized compulsory lecture course accompanied by a series of laboratory exercises for students in the Bachelor's degree program, majoring in Analysis and Control/Chemical Analysis and Quality Control; the course is offered as an elective subject for all majors at the Faculty of Chemistry of Plovdiv University;

(b) "Biocatalysis and Bioelectrochemistry" – an elective lecture course for all bachelor's degree majors taught at the Faculty of Chemistry of Plovdiv University;

(c) "English for Chemists" – an elective seminar course offered to all bachelor's degree majors taught at the Faculty of Chemistry of Plovdiv University.

Between 2011 and 2025, Assoc. Prof. Dimcheva was the academic supervisor of one doctoral student and co-supervisor of three other doctoral students, all of whom successfully defended their dissertations to obtain a PhD degree. She is currently the scientific supervisor of a full-time doctoral student enrolled in April 2025. The topics of the dissertations are closely related to the candidate's research and concern the development of electrochemical and bioelectrochemical systems suitable for the electroanalytical determination of bioactive substances.

The educational, pedagogical, and organizational activities of Assoc. Prof. Dimcheva demonstrate impressive teaching experience and a significant contribution to the activities of the Faculty of Chemistry at Plovdiv University. As head of the Department of Physical Chemistry for the past seven years, she has undoubtedly been involved in the administrative organization of the department's work and the activities of the Chemical Faculty at the University.

For participation in the competition for professor, Nina Dimcheva presented 40 articles, two chapters from collective monographs, one patent, and two teaching aids, all published after her election as associate professor in July 2006. Of the articles submitted, 32 are in scientific publications that are referenced and indexed in the world-renowned Scopus and Web of

Science databases, and the remaining eight are published in referenced publications without an impact factor. It is noteworthy that most of the works have been published in renowned international journals with high rankings, such as Analytical and Bioanalytical Chemistry, Analytical Chemistry, Bioelectrochemistry, Biosensors and Bioelectronics, Food Chemistry, Journal of the Electrochemical Society, etc. According to the rank of the journals, the publications are distributed as follows: 10 articles in Q1 journals, 12 articles in Q2 journals, 4 articles in Q3 journals, and 5 articles in Q4 journals. Ten of the articles were published in Bulgarian journals (Bulgarian Chemical Communications and Ecologia Balkanica), and all the others were published abroad. One of the two book chapters was published in the collective monograph Intelligent and Biosensors by INTECH (2010). It is devoted to the mathematical modeling of the influence of temperature and acidity on the characteristics of dopamine biosensors. The second chapter is part of the book "Nano-sciences and Nano-technologies" (Y. Dimova, editor, Paisii Hilendarski University Press, 2017) and summarizes experimental research on the electrochemical deposition of nanostructures of noble metals (Pt, Pd, Au) and their bimetallic combinations.

As equivalent to a habilitation thesis, Assoc. Prof. Dimcheva has presented six thematically related publications devoted to research on electrochemical biosensors, which have been published in journals with Q1 - one publication), Q2 (three publications), Q3 (one publication), and one article in a refereed journal without an impact factor. One of the publications in this group is a review devoted to the use of electrodes modified with metal and bimetal structures in enzyme biosensors [1].

All works submitted for the competition, with two exceptions (one review article in Current Opinion in Electrochemistry and a chapter from the book "Nanoscience and Nanotechnology"), were co-authored, with Assoc. Prof. Dimcheva being the first author in eight of them in six she is the second author, and in 12 publications she is the third author. The remaining works have more co-authors, some of which are the result of interdisciplinary research in collaboration with a wide range of specialists from scientific institutions in Bulgaria and abroad. These publications undoubtedly testify to the good integration of Assoc. Prof. Dimcheva in various research teams and her valued expertise.

The scientific activity of Assoc. Prof. Dimcheva concerns the development of electrochemical sensors and biosensors, focusing on two main areas: (1) modification of

electrode materials with metallic and bimetallic nanostructures in connection with the production of catalytically active electrodes participating directly or indirectly in biochemical reactions and (2) immobilization of suitable enzymes on unmodified and modified electrodes with a view to developing electrochemical biosensor devices. These two research directions are covered both in the publications presented as equivalent to a habilitation thesis and in the other works, participating in the competition, and therefore the main characteristics of the scientific activity and contributions will be considered as a whole.

The modification of electrode surfaces has been carried out with metals such as Au [2,3,10,12,14,30,35,36], Rh [17,26,28], Os [32], and complex compounds of osmium [8] as follows:

(1) Various electrochemical modes have been developed for the electrodeposition of gold particles on graphite [2,3, 12,30,35] and glassy carbon [10,14,36] with the ultimate goal of immobilizing enzymes and proteins (containing sulfur-containing amino acids in their protein shell) through the formation of a chemisorption bond between gold and sulfur. Good direct electrocatalytic activity of gold nanostructures for the oxidation of ascorbyl palmitate in a mixed water-alcohol medium has been demonstrated [12].

(2) The electrodeposition of rhodium has been studied on various substrates - glassy carbon [17], polymer membranes [26], and graphite [28], and by changing the metal modification regime. The amount of electrodeposited metal has been optimized to obtain electrocatalysts with maximum activity in specific reactions. It has been shown that the electrode materials obtained can be used as good catalysts for the reduction of hydrogen peroxide [17], the oxidation of ammonia [26], and formic acid [28].

(3) A new electrochemical method for depositing osmium on graphite has been developed [32] and the catalytic properties of osmium were used for the reduction of hydrogen peroxide.

In the field of modifying carbon electrodes with bimetallic structures, a series of publications [4,5,7,11, 18,29,31,33] is devoted to the development and optimization of methods for the electrodeposition of Pd-Pt and Pd-Au structures from electrolytes containing both types of depositing ions. In these studies, the successful combination of electrochemical and non-electrochemical methods such as X-ray diffraction analysis and scanning electron and atomic

force microscopy is particularly impressive, allowing a quantitative relationship to be established between the composition of the electrolyte and the content of the two metals in the metal deposit. A correlation has been found between the composition of the electrolytes used and the structure and morphology of the deposited bimetallic structures, as well as the relationship of these characteristics to the electrocatalytic activity of the modified electrodes for hydrogen peroxide reduction reactions [4,5,7,11, 18,29,31] and hydrogen evolution [33]. A procedure has also been developed for the chemical synthesis of Pt-Mn bimetallic nanostructures with a highly developed surface, acting as biomimetics in an electrochemical sensor for the diagnostic marker 5-hydroxyindoleacetic acid [6].

The second focus of the candidate's scientific activity is related to the development of electrochemical biosensors based on the immobilization of enzymes or proteins on unmodified and metal- and bimetal-modified electrode substrates. In the studies with which the candidate participates in the competition, protocols have been developed for the immobilization of the enzymes acetylcholinesterase [2,24], xanthin oxidase [4,18], glucose oxidase [5, 7, 11,18], and urease [26]. In these so called „first generation“ biosensor electrodes, the electrochemical signal is the result of oxidation or reduction of the enzyme reaction product (hydrogen peroxide, ammonia, or thiourea). In another group of biochemical components, the enzymes ascorbate oxidase [3,10], catalase [9], laccase [35], and the protein myoglobin [30] are immobilized. It has been established that in these cases, a direct transfer of electrons to the electrode (without the mediation of a mediator) takes place, whereby they can be used as „third-generation“ biosensor electrodes. The enzymes cellobiose dehydrogenase and laccase [16] have also been immobilized, enabling the oxidation of milk sugar and the reduction of oxygen.

As a result of the appropriate combination of catalytic electrodes with corresponding bioactive components (enzymes and proteins), the following types of electrochemical biosensors have been successfully developed:

(1) First-generation electrochemical biosensors for glucose [5,7,11], xanthine [4,18], urea [26], the neurotransmitter acetylcholine [24], and the pesticide monocrotophos [2]. In the cases of glucose and xanthine, high selectivity has been achieved with respect to typical interfering substances such as ascorbic and uric acids, glutathione, etc. The urea biosensor is characterized by a wide concentration range of linear response and high sensitivity of the

electroanalytical signal. In the electroanalytical determination of the pesticide monocrotophos, a low detection limit and high sensitivity have been achieved.

(2) Third-generation electrochemical biosensors for phenol [9] and ascorbic acid [3, 10]. A biosensor for phenol has been developed by directly immobilizing catalase on graphite, which shows different sensitivity depending on the origin of the enzyme (bacterial or animal source). A very good result has been achieved with the development of a biosensor for ascorbic acid [3,10], characterized by high sensitivity, a wide concentration range of linear response, high stability, and durability. Research on this biosensor is the basis of a patent (No. 66837 B1) entitled "Bioelectrocatalytic method for quantitative analysis of L-ascorbic acid."

(3) It has been shown that nanostructured inorganic catalysts made of PtMn and MnO2 have laccase-like activity and allow the electroanalytical determination of 5-hydroxyindoleacetic acid, a compound that is a marker for the diagnosis of carcinoid tumors. The developed sensor electrodes can be used in the practically applicable concentration range in urine and has been successfully used for the analysis of 5-hydroxyindoleacetic acid in real samples.

(4) A significant contribution is also the work on the creation of an electrocatalytic electrode using carbon nitride doped with Co_2O_3 [19,23], which can be used to determine peroxide compounds, including the peroxide value in vegetable fats.

Beyond the development of bioelectrochemical sensors, enzyme immobilization has been used for applications in biofuel cells. Based on laccase covalently bound to a gold surface and its electrocatalytic activity for oxygen reduction [35], a laccase bioelectrode suitable for use as a cathode in biofuel cells has been developed. An important contribution is the development of a biofuel cell [16] with lactose fuel, using electrodes modified with an osmium complex and immobilized enzymes - cellobiose dehydrogenase for the anodic reaction and laccase for the cathodic reaction.

Along with the works on the main topic developed by the candidate, there are several publications [20,21,22,34] dedicated to the study of the corrosion resistance of single- and multi-layer functional coatings deposited on steel and titanium alloys. These publications are the result of multidisciplinary collaboration between researchers from institutes of the

Bulgarian Academy of Sciences, Gabrovo University, and Sofia University, and testify to the broad competence of Assoc. Prof. Dimcheva in the field of electrochemical research.

The contributions of Assoc. Prof. Dimcheva's scientific research are of a scientific and applied nature and relate to the development of new and adaptation or optimization of existing methods for creating effective catalytic and biocatalytic systems. These systems are aimed primarily, but not only, to electrochemical biosensors with applications in medicine, the food and the cosmetics industry. The works testify to high scientific competence and a constant striving for improvement with a view to achieving enhanced electroanalytical properties - high sensitivity, a wide range of dynamic linear response, low detection limit, and high stability and durability of bioelectrochemical electrodes.

In the competition documents, Assoc. Prof. Dimcheva has submitted a citation report containing 60 citations of a single publication [11]. A review of Assoc. Prof. Dimcheva's profile in the Scopus scientific database shows that 21 of the works with which she participates in the competition have over 400 citations (excluding self-citations). In addition to work [11], papers [13,16,24] have over 50 citations, whereas papers [8] and [26] have over 30 citations. Among the most cited works by Assoc. Prof. Dimcheva are those related to the development of Pd-Pt and Pd-Au bimetallic nanostructures for the electrocatalytic reduction of hydrogen peroxide [11], a biofuel cell for lactose based on immobilized enzymes and osmium redox polymers [16], an amperometric sensor based on immobilized acetylcholinesterase [24], and a review article [13] on the use of noble metal nanostructures in protein-based biosensors. It is worth noting that, according to Scopus data, the total number of citations of Assoc. Prof. Dimcheva is 698, and her h-index is 16, which undoubtedly testifies to the international visibility and recognition of the candidate's scientific work.

4. Assessment of the personal contribution of the candidate

In more than 40% of the presented works, Assoc. Prof. Dimcheva is the sole, first, or second author, and in most of the remaining works, she has been the research supervisor. Therefore, I believe that her personal contribution has been significant, both in terms of the implementation of the research and in terms of formulating goals and objectives and developing strategies for their achievement. Scientific contributions are always the result of the collective efforts of all co-authors in a given study, but an overview of the materials presented leaves no

doubt that Assoc. Prof. Dimcheva's expertise was essential to the achievement of the scientific goals set.

5. Critical comments and recommendations

I have no critical comments on the materials presented.

6. Personal impressions

My personal impressions of the candidate are based on professional discussions on topics related to metal modification of electrodes and their use for electrochemical and bioelectrochemical sensors, as well as in connection with the joint organization and her participation in the BELCHEM 2024 conference. I am convinced that Assoc. Prof. Dimcheva is a highly erudite researcher with comprehensive and in-depth expertise in the field of physicochemical and electrochemical science, able to combine knowledge and experience to solve new problems and develop new directions in the field of electro- and bioelectrocatalytic materials.

CONCLUSION

The documents and materials submitted by Assoc. Prof. Nina Dimcheva for the present competition not only meet but also significantly exceed all requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria (ZRASRB), the Regulations for the Implementation of ZRASRB, and the relevant Regulations of Plovdiv University "Paisii Hilendarski".

The candidate has presented a significant number of scientific works, including two textbooks and one patent, published after the materials used in the defense of her PhD thesis and the competition for the academic position of "associate professor". The majority of Assoc. Prof. Dimcheva's works have been published in renowned foreign journals issued by the most famous international academic publishers. The candidate's works undoubtedly contain original scientific and scientific-applied contributions that have received significant international recognition. Her developments in the field of bioelectrochemical sensors are important for the advancement of this area of electrochemical research and, at the same time, are directly oriented towards practice, which makes them particularly valuable.

After reviewing the materials and scientific papers submitted for the competition and considering their significance and scientific and applied scientific contributions, as well as the candidate's intensive teaching activity, I am confident in giving a **fully positive assessment** of the candidate in this competition. On this basis, I would like to recommend that the Scientific Jury prepares a report-proposal to the Faculty Council of the Faculty of Chemistry for the election of Assoc. Prof. Nina Dimitrova Dimcheva to the academic position of "professor." at Plovdiv University "Paisii Hilendarski" in the field of higher education 4. Natural Sciences, Mathematics, and Informatics, professional field 4.2. Chemical Sciences (Physical Chemistry).

06.03.2026 Reviewer:

/Prof. Vesela Tsakova-Stancheva, DSc/