Review

Competition for the academic position "Professor" in professional field
4.2. Chemical Science (Physical Chemistry), announced in the State Gazette No. 41/20.05.2025

Candidate: **Assoc. Prof. Viktoria Milkova Nakova, PhD,**
Institute of Physical Chemistry, Bulgarian Academy of Sciences

Reviewer: Assoc. Prof. Dr. Plamen Hristov Tchoukov, Institute of Physical Chemistry - BAN, member of the scientific committee appointed by the Director of the Institute of Physical Chemistry - BAS, order No. 84-РД-09/19.06.2025.

For the competition for the academic position of "Professor" in field 4.2 Chemical Sciences (Physical Chemistry) for the needs of the Department of "Colloids and Surfaces" Institute of Physical Chemistry – BAS, application documents have been submitted by a single candidate – Assoc. Prof. Dr. Viktoria Milkova Nakova.

1. *Brief biographical notes*

Assoc. Prof. Nakova was born in 1975. In 1998, she obtained a master's degree in chemistry from the Faculty of Chemistry at Sofia University "St. Kliment Ohridski," specializing in Chemical Physics and Theoretical Chemistry. Between 1998 and 2000, she completed a postgraduate specialization in Engineering Chemical Physics at the same faculty, after which she was a full-time PhD student (2000–2004) in the Department of "Colloids and Surfaces" of the Institute of Physical Chemistry (IPC). Since 2004, she has held consecutive positions at the IPC: chemist (until 2006), assistant professor (2006–2014), and associate professor (since 2014). Since 2021, she has also been Head of the "Colloids and Surfaces" Department. Assoc. Prof. Nakova is a representative of the Institute at the General Assembly of the Bulgarian Academy of Sciences and Deputy Chair of the IPC Scientific Council. She has completed two long-term specializations in leading international research groups: as a postdoctoral fellow at the Laboratory of Physical Chemistry and Colloid Science, Wageningen University (2010–2011), and as a visiting researcher at the Institut für Biology und Biotechnologie der Pflanzen, Westfälische Wilhems-Universität Münster, Germany (2014-2015).

2. *Review of the submitted materials*

Dr. Nakova has submitted all the required documents for participation in the competition, and they meet the requirements of the ZRASRB (Law on the Promotion of the Academic Staff in

the Republic of Bulgaria), the Regulations for its implementation (PP ZRASRB), and the Regulations for Holding Academic Positions at the Institute of Physical Chemistry "Acad. R. Kaishev." In compliance with Article 53, paragraphs 1 and 2 of PP ZRASRB, she has provided a Diploma for the educational and scientific degree "Doctor" No. 30596 / 19.06.2006, in the scientific specialty 01.05.05 "Physical Chemistry," issued by the Higher Attestation Commission (VAK), as well as a Letter of work experience in the field of the competition No. 230/09.06.2025 from the Institute of Physical Chemistry, BAS. A statement has been submitted in accordance with Article 2b of the ZRASRB demonstrating fulfillment of the minimum requirements of the Institute of Physical Chemistry for occupying the academic position of "Professor" (Appendix 1 to the Regulations on the Conditions and Procedures for the Acquisition of Scientific Degrees and for Holding Academic Positions at the Institute of Physical Chemistry – BAS). According to the submitted evidence, Assoc. Prof. Nakova meets the requirements in the following groups of indicators:

Group of Indicators A. In 2006, she has defended a dissertation with title "Electro-optical investigation of the structure and electrical properties of polyelectrolyte multilayers on colloidal particles". The PhD thesis is based on 5 articles, of which 3 were published in Q1 journals and 2 in Q2 journals. The PhD thesis abstract is submitted with the set of documents. (50 points)

Group of Indicators B. As equivalent to a habilitation thesis, 5 publications were presented, 4 of which are in Q1 journals with impact factor and one article in a new multidisciplinary MDPI journal, *Sci*. In these articles, Assoc. Prof. Nakova is the sole or first author, which is proof of her personal contribution to the results. (Total: 110 points, with a minimum requirement of 100 points)

Group of Indicators C. Beyond the works listed under Group B, 11 additional publications were presented: 3 articles in Q1 journals, 6 in Q2, 1 in Q3, and 1 book chapter. (Total for Group C: 225 points, with a minimum requirement of 220 points)

Group of Indicators D. According to a Scopus check as of 22.09.2025, the candidate has a total of 209 citations, excluding self-citations by all authors. In the report used to verify compliance with the minimum requirements for the competition, only 61 citations were included. (Total: 122 points, with a minimum requirement of 120 points)

Group of Indicators E. Assoc. Prof. Nakova is the principal investigator of three national projects (two completed successfully and one ongoing) funded by the National Science Fund, with a total attracted budget of BGN 495,000. She has also participated in 1 national and 9 international scientific projects. (Total: 369 points, with a minimum requirement of 150 points)

As evidenced by the summary of all groups of indicators, Assoc. Prof. Nakova fully meets, and in some categories exceeds, the minimum quantitative requirements set by the ZRASRB and the requirements of the Institute of Physical Chemistry – BAS for holding the academic position of "Professor."

3. *General Overview of the Candidate's Research and Applied Scientific Activities.*

Assoc. Prof. Nakova's scientific work is focused on the study of polyelectrolyte adsorption onto model particles in aqueous media and the analysis of the electrical properties and stability of the resulting colloidal solutions. These studies primarily employ complementary electrokinetic techniques such as electric field light scattering, dynamic light scattering, and microelectrophoresis. Main results can be summarized in the following topics:

1. Investigation of the correlation between the physicochemical characteristics of polysaccharides and their ability to stabilise model colloid-polymer suspensions;

2. Formation and characterisation of multilayer films of polysaccharides and carbon nanomaterials (carbon dots) on non-spherical particles;

3. Development and characterisation of model polysaccharide-based systems for delivery and controlled release of active components.

These investigations span a wide spectrum, ranging from fundamental studies on the mechanisms of stability of colloid–polymer suspensions to applied aspects with potential applications in medicine, pharmacy, and the development of new nanomaterials. It should be emphasized that Assoc. Prof. Nakova has played an important role in maintaining interest in one of the traditional and original methods of the Department of "Colloids and Surfaces", light scattering in electric field, and in applying it to novel colloid–polymer systems of practical significance. The importance of her research is also evident by her active participation in 9 international projects and leadership of 3 national projects with a predominantly applied orientation.

4. *Main Scientific and Applied Scientific Contributions.*

The contributions in topic 1 are based on publications No. 1, 3, 9, 11, and 16 and are related to the properties of colloidal suspensions with adsorbed chitosan and alginate on lecithin-stabilized emulsion droplets and ellipsoidal β-FeOOH nanocrystals. Chitosan and alginate represent polyelectrolytes of different nature – cationic and anionic. Their variability in molecular weight, degree of acetylation, and M/G ratio makes it possible to trace the relationship between the physicochemical characteristics of the polysaccharides and the stability of model colloid–polymer suspensions, including their manifested electro-optical properties. A total of 13 original

contributions have been formulated in this area. Of particular interest from my perspective are the results obtained from the adsorption of chitosan onto lecithin-stabilized emulsion droplets:

- For the first time, it has been experimentally confirmed that hydrophobic interactions (at high degree of acetylation, DA) and electrostatic interactions (at low DA) dominate the adsorption of chitosan onto charged surfaces.
- Through electrokinetic analysis of secondary nanoemulsions stabilized with lecithin and chitosan oligosaccharides (COS) with 4–5 uncharged monomers, it was demonstrated that the ζ-potential decreases without reaching surface charge reversal. It was established that COS adsorption is driven by hydrophobic interactions with the lecithin layer stabilizing the oil droplets, while the reduction of the electrokinetic charge results from a shift of the slipping plane. At low COS concentration, a thin monolayer is formed, whereas at higher concentrations, several layers build up due to intermolecular hydrophobic interactions.
- Electrokinetic results show that the isoelectric point of the droplets and the surface charge reversal are independent of the polymer's molecular weight when DA < 28%. At DA > 28%, the isoelectric point and surface charge reversal shift toward higher polymer concentrations, since U_{ef} depends on the number of adsorbed charges rather than on the molecular weight.
- It was established that the amount of adsorbed chitosan (around 0.22 mg/m²) in the stabilized emulsion does not depend on the molecular weight or DA of the polysaccharide.

From the studies of the electro-optical properties of aqueous suspensions of ellipsoidal β-FeOOH nanocrystals with adsorbed alginates of different molecular weight and M/G ratio, the following important results were obtained:

- It was found that the isoelectric point of the particles in the presence of the polymer does not depend on its characteristics (achieved at alginate concentration of about 10^{-4} mg/mL). With further increase of alginate concentration, surface charge reversal and stabilization of the suspension occur (at about 2×10^{-2} mg/mL).

The contributions in topic 2 are based on the results of publication No. 2 in the list, which investigates the preparation and characterization of a stable multilayer film of alginate, chitosan, and negatively charged carbon dots (Cdots). The initial hypothesis of the study was that stable composite structures can be formed even at low negative charge density of the nanomaterials, and that presence of Cdots may modify the electro-optical properties of the suspension. For the first time, the method of electric field light scattering was applied to a colloid–polymer system

incorporating Cdots. The Cdots interact electrostatically with the positively charged monomers of chitosan deposited on the film surface in the preceding adsorption step. In general, the obtained results confirm earlier findings that the electrical properties of the component in the final adsorption step are decisive for the electro-optical behavior of the suspension, and they establish the following specific new effects resulting from the addition of Cdots:

- An anomalous oscillation of electrical polarizability and film thickness with respect to the layer number was recorded: a final alginate layer corresponds to a greater thickness and higher electrical polarizability γ value, whereas for particles with a terminal chitosan layer, and upon addition of Cdots, both the γ and the layer thickness decrease.
- A mechanism of film formation has been proposed in which the oscillation in thickness and polarizability is explained by the appearance of non-stoichiometric complexes in the suspension that adsorb onto the surface during the subsequent adsorption step. It was also established that the presence of H^+, the counterions of Cdots, is negligible in the mixed chitosan–Cdots layer.

The contributions in topic 3 are related to the development and characterization of model polysaccharide-containing carriers for the transport of active components and are based on publications No. 4, 5, 6, 7, 8, 10, 12, 13, 14, and 15. These publications, published in the last four years, clearly outline a new direction in Assoc. Prof. Nakova's scientific interests, with a distinct focus on applied research addressing current problems. In relation to the transport of pharmaceuticals and therapeutic substances, the following important contributions were made:

- Stable liposomes were obtained, stabilized with multilayers of poly- and oligosaccharides of chitosan, as well as with multilayer films of chitosan and hyaluronic acid or κ-carrageenan, suitable for encapsulation of bioactive components such as Veklury®, homotaurine, or extracts from medicinal plants;
- The drug Veklury® (Gilead Science Inc., Foster City, CA, USA), considered as a potential treatment for Covid-19, was successfully encapsulated.
- For the first time, stable liposomes loaded with therapeutic extracts of *Glycyrrhiza glabra L., Sambucus nigra, Aesculus hippocastanum, Potentilla reptans, and Allium sativum* were obtained and characterized.
- Oil-core nanocapsules suitable for the transport of pharmaceuticals and active molecules such as indomethacin, Veklury®, curcumin, and caffeine were developed.

- Using ion-induced gelation, chitosan particles loaded with a corrosion inhibitor (benzotriazole) were obtained, with potential application in enhancing the corrosion resistance of zinc coatings.

I accept the contributions formulated by Assoc. Prof. Nakova, which can be summarized as an enrichment of existing knowledge and the development and characterization of new nanomaterials of applied significance.

5. ***Impact of the Candidate's Scientific Publications in Bulgarian and International Literature.***

Assoc. Prof. Nakova is the author of 41 articles, which have received a total of 244 citations. As of September 20, 2025, the international database Scopus lists 37 publications with 209 citations (excluding self-citations by all authors) and an H-index of 10. A large part of the publications submitted for the competition are from the last four years, and despite the short time frame, they have already accumulated a significant number of citations, demonstrating both the relevance and the quality of these studies.

6. ***Critical Remarks and Recommendations Regarding the Candidate's Scientific Works***

I have no critical remarks regarding the candidate's research achievements or submitted for the competition documents. Over the past two years, I have witnessed Assoc. Prof. Nakova's efforts to engage young people—undergrad, master and doctoral students—to become acquainted with and further develop in this interesting scientific field. At present, this proves to be a challenging task, and I truly wish her success in this endeavor.

7. ***Personal Impression of the Candidate.***

I have known Assoc. Prof. Nakova since 2000, when she began her doctoral studies in the "Colloids and Surfaces" Department of the Institute of Physical Chemistry. Although we do not have joint research or publications, through participation in internal and institute seminars, as well as through informal discussions in the laboratory, I had the opportunity to closely follow her scientific development — from a motivated and inquisitive doctoral student to an independent researcher and established scientist in the field of this competition. I would like to emphasize the significant number of successful scientific collaborations that Assoc. Prof. Nakova maintains with leading international scientists. Equally impressive is her ability to successfully combine her scientific work with administrative and leadership responsibilities, the preparation and management of a considerable number of research projects, as well as her family commitments.

In conclusion

The submitted scientific works and supporting materials demonstrate that Assoc. Prof. Dr. Viktoria Milkova Nakova is an established scientist in the field of this competition. In terms of scope, quality, and scientific metrics, her scientific achievements fully meet the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, its Implementing Regulations, and the Requirements for Holding Academic Positions at the Institute of Physical Chemistry "Acad. R. Kaishev" at BAS, in the professional field "Chemical Sciences," scientific specialty "Physical Chemistry."

With full confidence, I recommend to the esteemed members of the Scientific Jury and the Scientific Council of the Institute of Physical Chemistry "Acad. R. Kaishev" to award the academic position of "Professor" in professional field 4.2. Chemical Sciences, scientific specialty Physical Chemistry, to Assoc. Prof. Dr. Viktoria Milkova Nakova.

Member of the Scientific Jury:

Date: 22/09.2025 Assoc. Prof. Plamen Tchoukov, PhD