REVIEW

for the competition for the academic position of "Professor" in professional field 4.2. Chemical Sciences, in the scientific specialty "Physical Chemistry," for the needs of the Department of "Surfaces and Colloids," announced by the Institute of Physical Chemistry "Academician Rostislav Kaishev," BAS, published in the "State Gazette," issue No. 41 of May 20, 2025, with the sole candidate

Assoc. Prof. Dr. Viktoria Milkova Nakova

Reviewer: Prof. Konstantin Todorov Balashev, D.Sc.

1. General Provisions and Brief Characteristics of the Candidate

Assoc. Prof. Dr. Viktoria Milkova Nakova was born on December 4, 1975, in Sofia. She received her higher education at the Faculty of Chemistry of Sofia University "St. Kliment Ohridski" (1998–2000), and in 2004 she defended her doctoral dissertation at the Institute of Physical Chemistry, BAS, on the topic *"Electro-optical study of the structure and electrical properties of polyelectrolyte multilayers on colloidal particles."*. Her entire professional career has been devoted to the Institute of Physical Chemistry, BAS, where she began as a chemist (2004–2006), advanced to research associate and senior assistant (2006–2014), and, following her habilitation in 2014, was appointed to the academic position of Associate Professor. Since 2021, she has served as Head of the Department of Surfaces and Colloids. Assoc. Prof. Milkova has also completed specializations at several prestigious European universities, including Wageningen University (Netherlands), the University of Münster (Germany), and Umeå University (Sweden).

2. Description of the Submitted Materials

Assoc. Prof. Milkova has prepared and submitted a tabular report verifying compliance with the minimum national requirements for attaining the academic position of Professor. She has also provided a list of five publications, all published in Q1 quartile journals, which are recognized as equivalent to a habilitation thesis. Her candidacy is supported by a substantial body of scientific contributions, including publications in leading international refereed journals, conference proceedings, and book chapters, as well as active participation in national and international scientific conferences. According to the Scopus database, she has 37 indexed articles with more than 300 citations in total and an h-index of 12.

The indicators submitted in groups A–E exceed the minimum requirements, with achieved scores as follows: 50 for group A, 110 (minimum 100) for group B, 225 (minimum 220) for group C, 122 (minimum 120) for group D, and 369 (minimum 150) for group E. These results are summarized in the following table:

Group Indicators	National Requirements	IPC-BAS Requirements	Achieved Points
А	50	50	50
Б	100	100	110
Г	200	220	225
Д	100	120	122
Е	150	150	369

The publications of Assoc. Prof. Milkova appear in leading specialized journals such as *Colloids and Surfaces A*, *Colloids and Surfaces B: Biointerfaces*, *Langmuir*, *Food Hydrocolloids*, *Progress in Organic Coatings*, *International Journal of Biological Macromolecules*, *Advanced Materials*, and others. Her research is directly aligned with the announced competition in Physical Chemistry and addresses topics including biopolymer adsorption, the structure and electrical properties of polyelectrolyte multilayers, biocompatible nanomaterials, and functional nanostructures for pharmaceutical applications.

She has also submitted a complete list of all citations (244 in total), attesting to the broad international recognition of her scientific contributions.

Her portfolio of projects includes both national initiatives (National Fund for Scientific Research) and international programs (FP7, COST, OP "Science and Education for Smart Growth"), in many of which she has served as project leader or member of governing bodies. In addition, Assoc. Prof. Milkova has provided lists of conference presentations at national and international forums, as well as records of research specializations abroad, which reflect her strong international experience and scientific mobility.

3. General Characteristics of the Candidate's Research, Teaching, and Applied Scientific Activity

The research of Assoc. Prof. Milkova is centered on colloid and surface physical chemistry. For more than two decades, she has pursued investigations that successfully integrate fundamental studies with applied perspectives. Her main research directions include the study of the electro-optical properties of polyelectrolyte multilayers, biopolymer adsorption, the development of

nanocapsules and liposomes for drug delivery, and the design of functional nanostructures for medical applications.

Her teaching activity constitutes an essential part of her academic profile. She has supervised, mentored, and advised diploma and doctoral students, participated in master's programs and lecture courses in physical and colloid chemistry, and contributed to the training of young scientists through projects with an educational component. In this way, she not only imparts knowledge and experience to the next generation of researchers but also ensures continuity and fosters the development of the established scientific school within the Department of Surfaces and Colloids at the Institute of Physical Chemistry, BAS.

Equally significant is her applied research activity. Through projects supported by the Fund for Scientific Research and international programs such as FP7, COST, and OP *Science and Education for Smart Growth*, she has developed biopolymer systems for the treatment of socially significant diseases such as COVID-19 and Alzheimer's and created "smart" materials and biocompatible nanostructures with potential applications in biomedicine and pharmaceuticals. Her research activity has been further enriched by participation in national and international scientific forums, as well as by specializations undertaken at prestigious European universities, which have broadened both her scientific expertise and international collaborations.

Taken together, these accomplishments demonstrate that the research, teaching, and applied activities of Assoc. Prof. Milkova successfully combine fundamental physical chemistry with practical developments of direct relevance to contemporary science and practice. Her scientific output is distinguished by its substantial volume, international visibility, and evident contribution.

4. Main Scientific and Applied Contributions

The scientific contributions of Assoc. Prof. Milkova, presented in this competition, are focused on one of the most dynamic areas of contemporary physical chemistry – the adsorption of biopolymers on model surfaces and its implications for the stability and functionality of dispersed systems. Her work encompasses three major research directions, which integrate fundamental and applied aspects and convincingly demonstrate the potential of her investigations to advance theoretical understanding while also enabling the creation of new materials of practical importance.

The first direction addresses the relationship between the physicochemical characteristics of polysaccharides, mainly chitosan and alginate, and their ability to stabilize model polymer suspensions. Assoc. Prof. Milkova has introduced a systematic approach to analyze how molecular weight, degree of acetylation, the M/G block ratio in alginates, and environmental conditions affect adsorption and the electrokinetic behavior of the resulting structures. For the first time, it has been

experimentally demonstrated that electrostatic and hydrophobic interactions between the monomeric units of chitosan and charged surfaces are critical to the stability of emulsion systems, and that key parameters, such as the degree of acetylation, determine the possibility of charge reversal and the control of surface properties. A notable contribution is the identification of a critical threshold (DA ≈ 28%), beyond which the electrokinetic behavior changes character, opening new perspectives for the rational design of biopolymer stabilizers. The studies on alginates further reveal important regularities – for example, the role of Ca^{2+} ions in determining the stability and electro-optical response of the systems, and the correlation between polymer structure and the observed electrokinetic properties.

The second direction is devoted to the fabrication and characterization of multilayer films composed of polysaccharides and carbon nanomaterials (so-called carbon dots) deposited on non-spherical particles. By applying a layer-by-layer adsorption technique and using electro-optical methods, Assoc. Prof. Milkova has shown how electrostatic interactions between polysaccharides and nanomaterials lead to the formation of composite structures with unique properties. It has been established that the incorporation of carbon dots into the films not only alters the electrokinetic charge but also affects the polarizability and thickness of the layers, thereby creating opportunities for the development of new functional materials with applications in biosensing, medicine, and pharmacy. Particularly novel is the use of electro-optical techniques for the study of such carbon-containing composite systems, which highlights the originality of the approach and enriches the methodological toolkit available in the field.

The third direction concerns the development and characterization of model polysaccharide-based systems for the transport and controlled release of active compounds. These studies have yielded stable liposomes and oil-core nanocapsules loaded with various bioactive substances – the drug Veklury® (remdesivir), homotaurine, curcumin, caffeine, as well as natural extracts from Bulgarian flora with proven antiviral and antibacterial activity. It has been demonstrated that the appropriate selection of polysaccharides and experimental conditions enables the preparation of fully biocompatible carriers that not only preserve the activity of the encapsulated agents but also ensure their targeted action and controlled release. Particularly original are the results concerning the aggregation of amyloid peptides in the presence of liposomes containing an anti-amyloid agent, as well as the development of liposomal systems with anti-coronavirus activity. Additional work has led to nanostructures with applications in materials science, such as corrosion-resistant zinc coatings modified with chitosan nanogels.

It should be emphasized that these three directions – stabilization of suspensions with chitosan and alginate, creation of multilayer polysaccharide–carbon films, and development of polysaccharide-

based drug carriers – are organically interconnected and define a coherent scientific program fully aligned with the strategic priorities of the Institute of Physical Chemistry at BAS, namely the design, characterization, and optimization of nanostructured materials for applications in medicine, pharmacy, and industry.

In summary, the contributions of Assoc. Prof. Milkova combine fundamental and applied research and clearly establish her as a leading investigator in the field of biopolymer adsorption and the development of innovative polysaccharide nanostructures. These contributions have been published in top-ranked international journals (Q1 and Q2), presented at numerous international scientific forums, and integrated into national and international projects – all of which attest to their high scientific value and international significance.

6. Critical Notes and Recommendations on the Candidate's Scientific Work

The scientific output of Assoc. Prof. Milkova is of high quality, diverse, and clearly characterized by original contributions across a broad thematic scope, reflecting her ability to address interdisciplinary problems. At the same time, it also reveals the potential for a stronger future integration of the individual research lines into a unified scientific school, one that would combine fundamental discoveries with applied developments and thereby enhance both their scientific and societal impact.

With respect to her teaching activity, Assoc. Prof. Milkova already has experience in supervising diploma and doctoral students. Nevertheless, it is both realistic and desirable for this experience to be further expanded through the development of courses for master's and doctoral programs in surface physical chemistry and biopolymeric nanostructures.

Overall, the recommendations for the future development of Assoc. Prof. Milkova are advisory in nature and oriented toward consolidating and expanding upon what has already been achieved: integrating the wide spectrum of research topics into a coherent scientific program, broadening her pedagogical role through the introduction of original courses, and continuing her active participation in international scientific projects and networks that contribute to the visibility and recognition of the Bulgarian school of physical chemistry.

7. Personal Impressions of the Reviewer Regarding the Candidate

I know Assoc. Prof. Milkova personally as a highly motivated and productive scholar. Over the years, I have had the opportunity to follow her career development and have consistently admired not only her strong scientific potential but also the collegial qualities that she has demonstrated at various scientific forums, conferences, seminars, and working meetings. My

impression is that Assoc. Prof. Milkova is an exceptionally conscientious and responsible researcher, as well as a colleague who fosters an atmosphere of trust, collaboration, and mutual respect. I am convinced that she is a worthy successor to the traditions of the Department of Surfaces and Colloids at the Institute of Physical Chemistry, BAS, and that through her work she makes a substantial contribution to the advancement and consolidation of the scientific school in this field.

Conclusion

The submitted materials clearly demonstrate that Assoc. Prof. Dr. Viktoria Milkova Nakova is an established scholar with significant contributions in the field of colloid and surface physical chemistry. She exceeds the requirements for the academic position of Professor, both in quantitative and qualitative terms. It should also be emphasized that all legal norms and requirements for holding this academic position have been fully met.

On this basis, I strongly and confidently recommend to the esteemed members of the scientific jury and the distinguished Scientific Council of the Institute of Physical Chemistry, BAS, that Assoc. Prof. Dr. Viktoria Milkova Nakova be awarded the academic position of Professor in the scientific specialty *Physical Chemistry*, within professional field 4.2. Chemical Sciences.

Date: September 9, 2025

Sofia

(Prof. Konstantin Balashev, D.Sc.)