REVIEW

of an application for the academic position "Associate Professor", in the professional field 4.2. Chemical sciences, for the scientific specialty "Physical chemistry", demanded by the section "Surfaces and colloids", announced in State Gazette, number 51 of data 13/06/2023 with a sole candidate:

Ch. Assistant Professor Dr. Plamen Hristov Tchoukov

Reviewer: Professor Konstantin Todorov Balashev

1. *General requirements and brief factual data of the candidate.*

Plamen Hristov Tchoukov was born on February 4, 1968, in the city of Stara Zagora, Bulgaria. In 1995, he graduated in physics from the Faculty of Physics of Sofia University "St. Kliment Ohridski" specializing in "Optics and Spectroscopy" and also acquired a second specialty "Physics Teacher". During the period 1998 - 2006, he was a full-time doctoral student at the Institute of Physical Chemistry "Acad. R. Kaishev" of the BAS (IPhCh-BAS), successfully defending a dissertation on the topic "Experimental study of self-organized amphiphilic structures in foam films", for which he was awarded PhD degree by the Higher Attestation Commission (diploma No. 30641/03.07.2006). In 2001, Dr. Tchoukov was appointed as a physicist at IPhCh-BAS and worked as such until 2006. After his PhD graduation he was appointed to the same institute as a first-degree research scientist, and later in 2011 he was promoted to chief assistant professor, a position that Dr. Tchoukov currently holds at IPhCh-BAS. He had a post-doctoral fellowship from January 2011 to June 2015 at the University of Alberta, Canada, where he researched the stabilization mechanisms of petroleum emulsions and the role of different petroleum fractions in the aggregation of asphaltenes and the effect on their rheological properties. During the period from 2008 to 2020, Dr. Tchoukov held several positions in the petroleum industry of Canada and in enterprises for the development of innovative products for anti-corrosion protection, hydrophobic coatings, etc., where he successfully applied and expanded his knowledge in the field of applied colloid chemistry and particularly in the design and fabrication of a unique instrumentation for electro-impedance spectroscopy of thin liquid films applicable for studying the stabilization mechanisms of thin water/oil types of liquid films.

As of today (September 11, 2023), in the Scopus database can be found 38 articles authored by Dr. Tchoukov. His *H-index* is 19, excluding self-citations by all co-authors.

2. *Description of the submitted materials.*

Dr. Tchoukov has submitted a list of 43 publications, of which 35 are in peer-reviewed journals, 5 are in conference and series proceedings, one is a co-authored book chapter, one patent application, and one open access internet publication in arXiv. I must mention that all

submitted publications cover entirely the scope of the announced contest. They are predominantly issued in the most renowned, specialized, and leading journals in the field of colloid chemistry, e.g., Advances of Colloid and Interface Science (1) Energy & Fuels (9), Langmuir (5), Colloids and Surfaces A: Physicochemical and Engineering Aspects (10), Journal of chemical engineering (1), Soft matter (1), etc. Dr. Tchoukov is the first author in six of these publications and the second in 15. His publications, which are equivalent to a habilitation thesis, are five, and those that do not repeat the ones presented in his PhD thesis are 12 (one of them is an application for a patent or a utility model). Dr. Tchoukov has participated with oral presentations and posters at a significant number (68) of international and national scientific forums. He also presented a list of 5 scientific projects funded by national funds and the Ministry of Education and Culture, in which he is a participant and three projects as a leader funded by Natural Resources of Canada.

The indicators of Dr. Tchoukov's activity significantly exceed both the minimum national requirements and those of the BAS and IPhCh- BAS established for the scientific activity of candidates for the academic position "Associate professor". This is demonstrated in the next table:

Group indicators	National requirements	Requirement of BAS	Requirement of IPhCh-BAS	Points scored
А	50	50	50	**50**
В	100	100	100	**140**
Г	200	220	220	**265**
Д	50	60	60	**2398**

3. *General characteristics of the research and scientifically applied activities of the candidate.*

Dr. Tchukov's fundamental and applied research activities are oriented toward contemporary national and European priorities well-known in modern colloid chemistry, as well as those traditionally established in IPhCh-BAS. His scientific research can be divided into four main categories:

1. Investigation of the mechanisms of stabilization of W/O petroleum emulsions and the effect of different crude oil fractions.

2. Design of unique scientific instrumentation for studying thin liquid films.

3. Investigation of drainage kinetics and interactions in thin liquid films formed between a flat solid surface and an approaching drop/bubble.

4. Investigation of the impact of adsorption layer's properties on thin liquid films' behavior.

The main results in Dr. Tchukov's research work were obtained by electro-impedance spectroscopy of thin liquid films of the water/oil type, and by utilizing for study of thin liquid films of a unique scientific setup designed and manufactured primarily by the candidate.

4. *Main fundamental and applied contributions of the research*

Dr. Tchukov's contributions can be systematized according to the above-mentioned four directions of his scientific achievements, as follows:

4.1. Mechanisms of stabilization of water/oil emulsions and the influence of different oil fractions [6, 10-12, 14, 15, 17- 20, 22, 23, 25, 26, 31, 33, 35].

The mechanism and influence of several factors on the stabilization of water/oil petroleum emulsions were investigated by performing a series of systematic experiments with thin liquid films in which:

a) The effect of bitumen concentration and solvent composition (aromatic/aliphatic) was determined by investigating thin liquid films of bitumen solutions with different concentration and solvent composition. It has been established that the lifetimes, thicknesses, and thinning rates of the water/bitumen films depend on the bitumen concentration, and it has been found that above the critical dilution, the water/oil boundaries "harden" and small aggregates of asphaltenes are formed [6, 11, 33, 35]. A new mechanism for the stabilization of water/oil petroleum emulsions is proposed, which does not imply the amphiphilic nature of asphaltenes. It allows to be explained the experimentally obtained drainage kinetics curves of the thin films, the higher-than-expected equilibrium film thicknesses and the observed "non-flowing dimples" [6, 10, 11, 12].

b) By studying the drainage kinetics, equilibrium thicknesses and lifetimes of water/oil thin films stabilized with bitumen, with asphaltenes and with asphaltene-removed bitumen, the role of different bitumen fractions in the stabilization of water/oil emulsions has been clarified and it was established the key role of asphaltenes for the stabilization of petroleum emulsions [12].

c) Based on the affinity of asphaltenes to the water/oil interface is proposed a procedure for the separation and characterization of the subfractions of asphaltenes responsible for the stabilization of water/oil emulsions. [15, 17, 19, 23, 25].

d) The effect of asphaltene aggregation on the rheological properties of bitumen solutions was investigated and it was found that above the critical dilution for precipitation of asphaltenes, the viscosity of the solutions decreases with time, while it was not observed a noticeable change in toluene and below the critical dilutions for solvents containing heptane, which was explained by the aggregation of asphaltenes and the formation of clusters that precipitate and reduce the content of asphaltenes in the solution [18, 22, 31, 43].

e) Destabilization mechanisms of water/crude oil emulsions were investigated using a modified version of the Scheludko-Exerowa cell with dosing system and rheometer, Brewster (BAM) and atomic force microscopy (AFM) measurements. The influence of biodegradable polymer demulsifier (EC300) on emulsion films of asphaltenes dissolved in heptol was also studied [14,16, 26].

4.2. Design of original scientific instrumentation for the study of thin liquid films [6, 16, 22, 26].

a) An automated apparatus has been developed for study of thin liquid films by the microinterferometric method, which allows the simultaneous application of a constant or variable electric field on a water/oil emulsion film, and utilizing specially developed software for the purpose, automated control of the formation of the film, registration, and analysis of experimental data on the intensity of reflected monochromatic light, applied pressure and temperature [6, 32].

b) A unique Integrated Thin Liquid Film Force Apparatus (ITLFFA) has been developed to simultaneously study the dynamic force and thickness profile of a thin liquid film, formed between a deformable drop/bubble and a solid surface, allowing measurements over a wide range of hydrodynamic conditions [16, 21, 24, 28].

c) A new version of the Scheludko-Exerowa cell with a dosing mechanism was developed, allowing modification of the chemical composition of an already formed thin film [26].

4.3. Drainage kinetics and dynamic interactions in thin liquid films formed between a drop/bubble and a flat solid surface [16, 21, 24, 28].

a) The influence of the approaching velocity between a bubble and a solid flat surface on the drainage of a thin liquid film was investigated and it was found that increasing the approach velocity of the bubbles significantly changes the hydrodynamic pressure in the film and affects its draining by forming a "dimple". The Stokes-Reynolds-Young-Laplace (SRYL) model has been shown to describe the basic physical properties of the draining film [21, 24].

b) Boundary conditions at the boundary water/hydrophobic solid interfaces were investigated and a new approach, which used the evolution of the thickness profile of the thin film, was proposed to determine the degree of mobility at the boundary water / hydrophobic solid interface [16, 28].

4.4. Relationship between the adsorption properties of a phase boundary and the kinetics and stability of thin liquid films. [1, 2, 3, 4, 5, 7, 8, 9, 13, 29]

The influence of the properties of the adsorption layer on the behavior of foam films and, in particular, the relationship between the equilibrium and dynamic adsorption properties of a single surface and the properties of foam films were investigated. It has been demonstrated with different types of surfactants that the adsorption behavior and dilatational rheology of the surface layers are closely related to the drainage kinetics and the stability of thin foam films [1-5, 8, 36, 37].

5. *Impact of the candidate's research in Bulgarian and international scientific literature*

Dr. Tchukov has presented in the documentation for the current contest 1199 citations, while the Scopus reference gives a significantly higher number of 1534 citations without the self-citations of all authors. This huge number of citations of the candidate speaks for itself, namely that his research work has not only found wide and excellent recognition in the scientific community but also that he has established himself as one of the world's leading researchers in the field of applied colloid chemistry science.

6. *Critical remarks and recommendations to the candidate*

I have no critical remarks towards Dr. Tchukov, and the submitted documentation, which has been completed thoroughly and according to the legal requirements. I would like to make only one wishful recommendation to Dr. Tchukov for his future advancement and research. With his scientific work and achievements, he is one of the successors of the world's leading schools in the field of physical and colloid chemistry, so it would be wonderful if he could share his vast experience and knowledge by attracting and guiding young and talented students and scientists.

7. *Personal impressions about the candidate*

I have known Dr. Tchukov long ago since we both started our scientific careers as doctoral students, and recently from his participation in the 27th ECIS conference held in Sofia in 2013. I also have direct impressions of the group at IPhCh- BAS, in which he pursues his career development. That is why the scientific results achieved by him and his scientific experience give me the confidence to believe that Dr. Tchukov has excellent prospects to be a perpetuator of traditions and achievements in the section "Surfaces and Colloids" in IPhCh-BAS, and to make his personal contribution to its future development in fundamental and applied colloidal chemistry.

CONCLUSION

The documents submitted by Dr. Tchukov, who is the only candidate in the announced contest for the associate professor at IPhCh - BAS, corresponds to the topic of scientific specialty 4.2. Chemical sciences, specialty "Physical Chemistry" satisfying and even exceeding the requirements of the law, the Regulations for its application in the Republic of Bulgaria, and the Regulations for its application in IPhCh - BAS. The candidate's contributions are indisputable and clearly distinguishable in the scientific community.

The analysis of his overall scientific research work and organizational activity gives me a solid reason to support the candidacy of **Ch. Assistant Professor Dr. Plamen Hristov Tchukov** and to recommend to the members of the respected scientific jury refereeing the contest as well as to the esteemed scientific council of IPhCh- BAS to award him with the academic position "Associate Professor" in the field 4.2. Chemical sciences with a scientific specialty "Physical Chemistry".

11.09.2021 г.

Sofia, Bulgaria

(Prof. Konstantin Balashev,PhD, DSc)