REVIEW

on the competition for holding an academic position 'Associate Professor' in professional field 4.2. Chemical Sciences, scientific specialty 'Physical Chemistry' for the needs of 'Interfaces and Colloids' section, announced in SG, issue 51, dated 13.06.2023, with a single candidate: Chief Assistant Plamen Hristov Tchoukov, PhD

Review from Assoc. Prof. Khristo Ivanov Khristov, PhD, member of the Scientific Jury (Order№ 88-РД-09, dated 20.07.2023 of IPC-BAS Director)

1. Brief professional biography and description of materials presented

Chief Assistant Plamen Tchoukov, PhD, graduated from *Sv.Kliment Ohridski* Sofia University, Faculty of Physics in 1995, with specialty Physicist in 'Optics and Spectroscopy'. In 2006 he defended a PhD thesis for educational and scientific degree 'Doctor' on 'Experimental Study of Self-Organized Amphiphilic Structures in Foam Films'. In 2011 he spent a post-doc year at the University of Alberta, Chemical & Materials Engineering, Edmonton, Canada. From 2012 to 2015 he was a researcher at the University. Until March 2023 he worked for various scientific organizations on colloid and chemical engineering projects associated mainly with the petrol industry. For instance, development of new study methods for water/oil emulsion films, new chemical products for food industry and public health system, for the petrol industry, etc. Since March 2023 he has been Chief Assistant at IPC-BAS.

Chief Assistant Plamen Tchoukov, PhD, enters the completion with 17 papers, 10 of which in Q1 and 7 in Q2 journals, and 1 published patent application. Instead of a Habilitation Thesis, he presents 6 papers in reviewed journals, 4 of them published in Q1 and 2 in Q2 journals. The total number of papers published in reviewed journals is 35, 5 papers in conference proceedings, and a book chapter. At present he has acquired 1199 citations. Dr. Tchoukov participated in 65 international and national scientific fora with presentations

and posters. He delivered 17 presentations. He was involved in 5 international contracts of IPC-BAS and was contract manager of 3 contracts in Canada.

All of the above makes it clear that Dr. Plamen Tchoukov fulfils not only the minimum national requirements and the requirements set by IPC-BAS Scientific Council for the Associate Professor academic position but substantially exceeds them.

2. Scientific and applied research activity

Dr. Tchoukov's scientific research has been conducted mainly at IPC-BAS, CanmetENERGY-Natural Resources Canada and University of Alberta, Canada. It covers the following domains: stabilization mechanisms of water/oil petrol emulsions and effects of various petrol fractions; design of unique scientific instrument to study think liquid films, thin liquid film draining kinetics and interactions in thin liquid films formed between a droplet/bubble and flat solid surface; relation between adsorption properties of surfactants at water/air interface and thin liquid film behaviour.

In petrol industry, formation of oil/water/oil emulsions is, in many cases, harmful or even dangerous because water droplets contain salts causing pipeline storage and equipment corrosion. Due to emulsions stability (long lifetime), their characterization by means of conventional methods such as centrifuging, phase separation time, etc. prove to be unsuitable.

As the two droplets of water approach each other they form a thin oil film between themselves. Eventually, the film may drain and the droplets coalesce. Alternatively, the film may stop drainage at a large distance and the droplets can then part. So, the properties of the oil film between water droplets govern overall emulsion stability Formation of rupture-stable emulsion films is one of the main factors defining emulsion stability. Study of film drainage and film

rupture may provide valuable information about coalescence mechanisms occurring among droplets which at present have not been fully clarified. Rupturing an emulsion film requires an external force which has to overcome film stabilizing disjoining pressure. This can be achieved by mechanical capillary pressure or by applying electric field onto the film. Dr. Tchoukov has devised automated equipment for micro-interferometric emulsion film study enabling an automated control over film formation, and registration and analysis of experimental data on reflected monochromatic light intensity, pressure or tension applied, and temperature. Independent measurement of film thickness and size by the Scheludko–Exerowa microinterferometric methodology on the one hand, and on the other, the possibility to apply direct or alternating electric field, opens entirely new opportunities to study water/oil/water emulsion film structure and stability. This method is described in detail in the part entitled: *Thin liquid film instrument for combined microinterferometric and electrochemical studies*.

This instrument is used to systematically explore the effect of various factors on emulsion film properties and stability. Looked into are bitumen concentration effects, bitumen fractions role, solvent type influence, etc. Established is a critical dilution (solvent/bitumen ratio) which coincides with asphalthene critical dilution of aggregation and precipitation in solution volume, and at which emulsion properties change dramatically. It is ascertained that alphalthene stabilized films (bitumen fraction) are considerably more stable than those obtained by solutions of other fractions. On the ground of these studies a new mechanism describing water/oil/water petrol emulsion stabilization is proposed. In films, asphalthenes form tri-dimensional aggregates which change liquid rheological properties and lead to a delayed liquid drainage, even to a ceased drainage altogether which in turn stabilize emulsion films and respectively, emulsions.

The microinterferometric method allowing for a constant or alternated electric field application and equipped with a dosing system is used to evaluate demulsifier efficacy. Studies show that films are stable without demulsifier addition while a biodegradable polymer demulsifier added to the film results in film rupture in about 20 seconds. Demulsifier overdosing renders a stabilizing effect. It is established that the demulsifier penetrated film surface layer and disintegrates asphalthene aggregates responsible for film stability.

Dr. Tchoukov has constructed an Integrated Thin Liquid Film Force Apparatus (ITLFFA) to study drainage of thin liquid film formed between approaching droplet/bubble and flat solid surface while measuring directly interaction force. The apparatus allows for interaction forces and drainage dynamics exploration of extremely short-lived films (milliseconds). Results obtained enable quantitative comparisons between theoretical and calculated film interaction forces and profiles. Examined is also the effect of droplet velocity approaching solid surface. These studies establish that with velocity increase, hydrodynamic pressure in the films changes significantly and affects film drainage by forming a dimple and increasing drainage time.

This apparatus has served to probe the boundary conditions at the water-hydrophobic solid surface. As established, hydrophobic surfaces accelerate liquid film drainage, and films are unstable and ruptured within milliseconds.

Described is also the link between interface adsorption properties and drainage kinetics and stability of thin liquid foam films. Dilatation rheology of surface layers for different surfactants is associated with film kinetics and stability. Surfactant concentrations, showing maximum dilatational elasticity, correlate with the transition from short-lived films to stable films. The same concentration range registers also an increased probability to observe specific black patterns, black dots and spots. These results are explained with specific

film hydrodynamics, mass transfer from the bulk to surface layers, factors controlling film tangential mobility and film stability.

Undoubtedly, Dr. Tchoukov's personal contribution is significant: in more than half of his scientific papers in high impact factor journals (Q1 and Q2), he is the first or second author.

The importance of Dr. Tchoukov's scientific research is unquestionable which is confirmed by the fact that close to 1200 papers have cited his papers.

This brief synopsis of Dr. Tchoukov's scientific work speaks for his theoretical knowledge and experimental skills to handle successfully the challenges of diverse scientific and applied research tasks. I am fully convinced that he can not only work independently but to train and manage young specialist.

CONCLUSION

The documentation presented for the purposes of the said competition makes it clear to me that Chief Assistant Plamen Hristov Tchoukov, PhD is a researcher with considerable and internationally recognized scientific contributions, who meets the requirements for holding the academic position of 'Associate Professor' in professional field 4.2. Chemical Sciences, scientific specialty 'Physical Chemistry' as laid down in the Law on Development of Academic Staff in Republic of Bulgaria and IPC-BAS criteria. His achievements and my excellent personal impression of the candidate give me reason to recommend strongly that the honourable members of the Scientific Jury vote positively on granting Chief Assistant Plamen Hristov Tchoukov, PhD the academic position of 'Associate Professor.

Sofia
12.10.2023

Signature:
(Ass. Prof. Khri