REPORT

regarding the competition for the academic position "Professor"

in the professional area 4.2. Chemical Sciences, scientific specialty "Physical Chemistry"

for the needs of Laboratory of X-ray diffraction methods and computed tomography

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with candidate Dragomir Mladenov Tatchev, doctor, associate professor

from the Institute of Physical Chemistry "Academician "Rostislaw Kaischew" - BAS

Member of the scientific jury: Irena Kirilova Mihailova, doctor, associate professor

from the University of Chemical Technology and Metallurgy

1. **General characteristics of the scientific research and scientific-applied activity of the candidate.** Assoc. Prof. Dr. Dragomir Tatchev is a co-author of 49 scientific papers, which have been published mainly in foreign specialized journals, in 13 of them he is the first author, and in two - the only one. The main thematic areas of the scientific and applied research of the candidate are related to the study of the formation or characterization of nanometric phases in different media and materials and to the development of the theory of small-angle X-ray scattering (SAXS) in multiphase systems.

In the competition for the academic position "Professor" the candidate participates with 34 publications, 10 of which are in journals in/from the group **Q1, 7** - in **Q2, 2** - in **Q3, 4** - in **Q4**; one publication is a chapter from a book, and the remaining 10 publications have been published in full text in proceedings of symposia, congresses, and conferences with Bulgarian and international participation. The documents submitted by the candidate Assoc. Prof. Dr. Dragomir Mladenov Tatchev to participate in the competition for the academic position "Professor" prove that he meets and significantly exceeds the legal requirements, including the minimum national requirements, respectively the requirements of BAS, as well as the requirements of the Scientific Council of IPC according to Appendix № 1 of the Regulations on the terms and conditions for acquiring scientific degrees and for holding academic positions at the Institute of Physical Chemistry - BAS. The candidate's points are: for indicators of group **"A" - 50** points, (the required minimum is 50); for indicators of group **"B" - 182** points, (the required minimum is 100); for indicators of group **"C" - 270** points, (the required minimum is 220); for indicators of group **"D" - 976** points (the required minimum is 120); for indicators of group **"E" - 360** points, (the required minimum is 150). (The required minimum points are specified in accordance with the above-mentioned Appendix № 1, as they are equal to or higher than other regulatory requirements.).

2. Main scientific and applied scientific contributions.

The publications with which Assoc. Prof. Tatchev participates in the competition are a natural continuation and deepening of the research in the above-mentioned topics. His personal contribution is indisputable. The main scientific and applied contribution of Assoc. Prof. Tatchev in his research papers is related to new scientific facts, enrichment of knowledge and theories,

and formulation of new hypotheses.

In a study of the primary crystallization of nickel in an amorphous nickel-phosphorus alloy, it has been shown that SAXS allows the determination of the nucleation rates and the growth rate of crystals. The kinetics of nickel separation, according to the literature, from anomalous small-angle scattering (ASAXS) agrees well with Kolmogorov and Avrami's theory of universal crystallization.

The separation of gold particles in a sodium-calcium glass was quantified by ASAXS and SAXS measurements. The behavior of the slowed down or delayed Oswald maturation/maturing due to X-ray irradiation was observed for the first time in the same system. The result is not only fundamental but also with a potential for application in optoelectronics.

A new two-stage method of data analysis from ASAXS has been developed, which quantitatively characterizes samples containing gold-silver alloys or bimetallic particles in sodium-calcium glass.

Spinel nanoparticles in the samples were characterized in studies of crystallization in heat-treated oxide glasses from the SiO_2 / Na_2O / Fe_2O_3 / MnO system by ASAXS and small-angle neutron scattering (SANS). The particles were found to be spinel solid solutions, with a spherical shape, core-shell structur and nuclei enriched in iron. The quantitative dependence of the composition of the nuclei on the duration of thermal treatment of the samples was determined.

A solution to the problem for the characterization of systems with metal or oxide particles locked in cavities of protein macromolecules with small-angle scattering (SAXS and SANS) has also been proposed.

The task of determining the structural position of copper added to silicoaluminophosphate (SAPO-5) by a combination of methods, including ASAXS, has been solved.

Studies to obtain platinum-based catalysts have shown that the use of ASAXS makes it possible to distinguish particles by composition and size, and it has been found that the composition of expected nickel particles applied on a carrier is closer to that of NiO, $Ni(OH)_2$ and NiOOH than pure nickel. The method for determining the composition of metal particles has been improved, which reduces the dependence of the result on a measurement error.

The theory of small-angle X-ray scattering by multiphase multi-component systems has been further developed by introducing single-phase scattering functions and interphase scattering functions taking into account the interference between a pair of phases. A generalized expression for the scattering invariant of a multicomponent multiphase sample has been derived. The theory is not limited to ASAXS; it can be applied to arbitrary methods of contrast variation. It covers in a consistent way the methods used so far to vary the contrast, gives a new perspective on their interpretation, and opens up possibilities for constructing new schemes for varying the contrast of the scattering. The exact approximations and assumptions, in which the equations for an n-component system are limited to those used in practice including two-phase systems, have been given. The exact approximations and assumptions for which the equations used for an n-component system are transformed to those used in practice, including the case of two-phase systems, are given.

By applying an appropriate combination of experimental methods - SAXS, XRD, and X-ray computed tomography, a hypothesis has been formulated justifying the reasons for the loss of capacity of the aluminum-ion battery during charging and discharging cycles. A modification of the Grazing incidence small-angle X-ray scattering (GISAXS) method has been proposed, which allows its application in temperature experiments. Thus, the change of the sol-gel yttrium-zirconium layers obtained by heating and annealing has been characterized.

3. Impact of the scientific publications of the candidate in the Bulgarian and foreign literature. The visibility of the scientific publications is adequately measured by the number of quotations in the scientific literature. The candidate, Assoc. Prof. Dr. Dragomir Tatchev participates in the competition with 488 citations of his publications, according to Scopus and Web of Science. This group of indicators alone gives to the candidate 8 times more points than required. I believe that this citation rate of the candidate's scientific publications in prestigious specialized scientific journals is a recognition of their relevance and high quality.

4. Critical remarks and recommendations to the scientific works of the candidate. I do not have any critical remarks and recommendations to the scientific work of the candidate.

CONCLUSION

My acquaintance with the materials submitted for participation in the academic competition, the topicality/relevance and importance of the research topics, the level of research, topic coverage, and candidates work exceeding the minimum scientometric indicators provided by law, give me a reason to give a positive assessment with conviction. As a member of the Scientific Jury, **I propose the candidate**

Assoc. Prof. Dr. Dragomir Mladenov Tatchev to occupy the academic position "Professor" in the professional area 4.2. Chemical Sciences, scientific specialty "Physical Chemistry".

11th September 2020 Prepared and signed by:

/Assoc. Professor. Eng. Irena Mihailova, Ph.D. /