**REVIEW**

**on competition for a professor position**
**in scientific direction 4.2. Chemical sciences, specialty Physical Chemistry**
**announced in SG №107 from 20.12.2024**
**with candidate Svetlozar Dimitrov Ivanov, Dr., Assoc. Prof.**
**Reviewer: Vessela Tsvetanova Tsakova-Stancheva, DSc, Prof.**

## 1. Background and brief biographical details of the candidate.

Assoc. prof. Ivanov was born in July 1976 in Sliven, Bulgaria. He studied at the Dobri Chintulov Natural and Mathematical High School in the same town with a major in Chemistry. He graduated from Sofia University "St Kliment Ohridski" in 2000 with a degree in Chemistry, specialization "Pure and extra pure substances and materials based on them". In the same year he joined the Institute of Physical Chemistry, BAS (IPC-BAS) as a chemist. From 2001 to 2005 he was a full-time PhD student at IPC-BAS. In 2006 he defended his dissertation "Modification of conductive polyaniline coatings by electro- and electroless deposition of metal particles" for the award of the educational and scientific degree "Doctor" in the scientific specialty 01.05.05 – Physical Chemistry. In 2007 he was elected as a Research Fellow at IPC-BAS. Subsequently (2010-2011) he worked as a postdoctoral fellow at Bar Ilan University, Ramat Gan, Israel in the group of the distinguished scientist and specialist in the field of lithium-ion batteries, Prof. D. Auerbach. Since 2011, Dr. Ivanov has been a researcher at the Technical University of Ilmenau, Germany. In 2019, he obtained the degree Assoc. Prof. from the Faculty of Electrical Engineering and Information Technology, Technical University Ilmenau with the topic "New materials and advanced analytical techniques for application in lithium-ion battery research and technology".

## 2. Description of the submitted materials

In the materials for the competition, Dr. Ivanov has submitted a list of a total of 65 scientific research papers and inventions, including 47 publications in scientific journals, four book chapters, 12 full-text publications in conference proceedings and two patent applications. The scientific papers have been published in the most reputable scientific journals in the field of electrochemical research such as Electrochimica Acta (11 publications), Journal of Applied Electrochemistry (8 publications), Journal of Power Sources (5 publications), etc. The patent applications have been filed with the US Patent Office. The book chapters are part of prestigious publications published by John Wiley and Sons, Elsevier and Springer.

For the competition for professor, Assoc. Prof. Ivanov has submitted evidence on groups of indicators according to the minimum requirements of IPC-BAS, adopted by the Scientific Council of the Institute (Annex No. 1 of the Regulations for the conditions and procedure for the acquisition of scientific degrees and for holding academic positions at the Institute of Philosophy and Science) as follows:

**Indicator group A**

Dissertation on "Modification of conductive polyaniline coatings by electro- and electroless deposition of metal particles", defended in 2006 on the basis of a total of six publications, three in journals with Q1 rank and three in journals with Q2 rank (50 points).

**Indicator group B**

Six scientific papers published in the period 2019-2022, three of which in journals of Q1 rank and three in journals of Q2 rank, have been submitted as equivalent to a habilitation thesis (135 points in total, with a minimum requirement of 100 points).

**Indicator group G**

In addition to the publications under indicator B, eight publications (6 in journals of Q1 rank and two in journals of Q2 rank), two book chapters and two patent applications were submitted. (Total of 250 points, with a minimum requirement of 220 points.)

The publications under indicators B and G do not duplicate those used for the award of the PhD degree and for habilitation as Associate Professor.

**Indicator group D**

A list of 63 citations of three publications from 2021 and 2022 was provided in the competition documents (126 points in total with a minimum requirement of 120 points). Only these citations are indicated in the Minimum Requirements Statement. Additionally, the competition documents contain a list of a further 60 citations to eight publications from Groups B and G, which would have yielded a further 120 points, but are not included in the candidate's Reference.

**Indicator group E**

The candidate has submitted a list of three dissertations for the degree of Ph.D. defended at Technical University (TU) of Ilmenau for which he was the co-supervisor (total 75 points). He submitted a list of participation in two projects funded by the Deutsche Forschungsgemeinschaft and two international projects funded by the European Regional Development Fund and UMICORE. He was the German team leader in an international project funded by UMICORE, which brought significant financial resources to TU Ilmenau. For all activities in indicator group F, the required documents have been submitted. (The total number of points in group F is 343 with a minimum requirement of 150 points.)

In conclusion, the submitted Statement of Minimum Requirements of the applicant corresponds to the factual evidence submitted and shows an over-scoring in all indicators. Even without taking into account the additional citations carrying 120 points, the applicant's score (904 points) exceeds the minimum required score of 640 points by more than 40 %.

**3. General characteristic of the candidate's scientific research and applied activity.**

The research activity of Assoc. Prof. Ivanov can be divided into two periods, before and after 2011, related to the introduction and active work in two different scientific topics. In the first period (2000 - 2011) Svetlozar Ivanov worked mainly in the field of electrochemical formation of electronically conductive polymer coatings, their characterization and modification with metal particles using various electrochemical and non-electrochemical approaches. He defended his PhD thesis on this topic and has 15 publications published in the period 2001-2013, mainly co-authored with colleagues from IPC-BAS. A considerable part of this research is also related to collaboration with the groups of Prof. V. Mirsky (University of Regensburg) and Prof. A. Bund (Technical University of Ilmenau). At that time, Dr. Ivanov was an active participant in bilateral research projects carried out by IPC-BAS and the University of Regensburg, Germany as well as in Science for Peace Programme projects carried out by IPC-BAS and the Institute of Catalysis - BAS, together with partners from Greece and the United Kingdom. The scientific contributions in the field of electron conducting polymers (ECPs) are mainly related to the clarification of the role of the oxidation-reduction state of the polymer coating for the initial stages of electrodeposition of metal phase, to the consideration of the role of metal anion complexes for modification of ECPs with metal particles. The factors by which the characteristics of metal particles can be influenced in a electroless metal deposition process are also identified. Publications from this period have over 350 citations in the international scientific literature.

In the second period of his scientific activity, Dr. Ivanov turned to the modern field of lithium-ion batteries and made a remarkable development as a scientist in this area. On this topic, he co-authored 31 publications in international journals, two book chapters and two patent applications, which received a total of over 700 citations in the international scientific literature. The main lines of research in this field are related to the synthesis of new materials suitable for electrodes in lithium-ion batteries and the development of new methods for their characterization. The contributions of the publications on this topic, with which the candidate is competing for the professorship, will be discussed in detail in section 4 of this review. Here I will draw attention to some contributions from publications used in the procedure for the title of Associate Professor:

- A thin-film calorimeter has been developed to study the thermodynamic properties of thin films, applied to study the thermodynamic properties of various energy storage materials used in lithium-ion batteries (J. Appl. Electrochem. 43 (2013) 559, J. Mater. Sci. 48 (2013) 6585, J. Electrochem. Soc. 162 (2015) A727, Int. J. Mater. Res. 108 (2017) 904).
- Nanoparticles of anatase doped with sulfur and carbon were synthesized via a one-step interaction process between thiourea and metatitanic acid and used as anode material in lithium-ion batteries, exhibiting high capacity and accelerated lithiation/delithiation kinetics (Nanoscale Research Letters, 11 (2016) 140, J. Power Sources, 326 (2016) 270)
- Intercalation-induced macroscopic expansion of electrodes for lithium-ion batteries has been investigated using the electrochemical in-situ dilatometry method, and a theoretical approach has been developed to estimate reversible electrode expansion using a small number of material-specific initial parameters (J. Power Sources, 342 (2017) 939). An electrochemical-mechanical model of a lithium-ion cell has been established based on the effects of electrode expansion, voltage generation, electrode and separator compression, external cell expansion, and finally the influence of ion transport in the porous electrodes and separator. For the first time, the physical principles of pore structure compression are directly related to the electrochemical model of electrode processes in the cell (J. Power Sources, 378 (2018) 235.

The scientific activity of Assoc. Prof. Ivanov in the second period of his scientific development is distinguished by the use of a rich toolbox of electrochemical and non-electrochemical methods. Along with conventional methods, methods developed in the candidate's works, such as thin-layer calorimetry, electrochemical dilatometry, in-situ analytical method combining amperometry at zero resistance and gravimetry, etc., should be outlined.

The second period of the scientific activity of Assoc. Prof. Ivanov was also characterized by intensive project and teaching activities. He was involved in several projects with German or international funding, and in the period 2021-2024 he was the German team leader in a large project with significant funding, concluded between TU Ilmenau and the company Umicore. He was co-supervisor of three PhD students and lecturer on "Electrochemistry and Corrosion" and "Electrocrystallisation" for undergraduate, bachelor and master students at the University of Ilmenau.

**4. Main scientific and scientific-applied contributions.**

The candidate has attached in the documents for participation in the competition a Statement of Scientific Contributions, which covers his overall scientific activity. The contributions are divided into three

groups - contributions of the publications included in the doctoral dissertation; contributions of the publications submitted in the habilitation procedure for Associate Professor; publications in specialized scientific journals, which do not repeat those submitted for the acquisition of the educational and scientific degree "Doctor" and for the academic position of "Associate Professor". All scientific works of the last group were published in the period 2019-2023, which testifies to an extremely intensive scientific activity in the last five years. Only the contributions from this group of publications that are directly relevant to the current competition will be considered in the following. They can be summarized in the following three thematic areas:

**A. Electrodeposition of silicon to produce silicon-containing anode materials suitable for lithium and sodium ion batteries:**

- Sulfolane was used for the first time as a chemically stable, low-toxic and cost-effective solvent in an electrolyte for electrodeposition of silicon layers on a copper substrate. It was found that at low overvoltages, it is possible to obtain silicon coating with high elemental silicon content and low organic contaminant content (Electrochem. Commun, 103 (2019) 37). When compared with electrodeposition from ionic liquid, the advantages of electrodeposition of silicon from a sulfolane solution are made apparent, namely high solution stability and, consequently, no contamination of the silicon layer with electrolyte decomposition products (ACS Appl. Mater. Interfaces 12 (2020) 57526).
- The proposed sulfolane electrolyte has been successfully used for electrodeposition of silicon on porous copper substrate. An anode for lithium-ion batteries with high specific capacitance in lithiation/delithiation and stability under repeated cycling, effects due to the improved mechanical stability of the active material and to the accelerated ion transport in the porous structure of the anode, was obtained (Electrochim. Acta 380 (2021) 138216).
- A composite Si-O-C anode for sodium-ion batteries with very good characteristics (specific capacity and Coulombic efficiency) compared to other Si-based anode materials has been prepared using electrodeposition from a sulfolane electrolyte (Energy Technology 10 (2022) 2101164).

**B. Optimization of functional properties of lithium ion batteries by new anode materials and development of new methods for their investigation:**

- Electrochemical dilatometry was used to obtain results concerning the interfacial properties of a graphite anode in the presence of vinyl carbonate, important for the design of high-performance lithium-ion batteries (J. Power Sources 457 (2020) 228020).

● A relatively simple approach to form Ni-NiO core-shell type structures by chemical reduction in the presence of hydrazine and subsequent temperature treatment is proposed. The resulting metal/metal oxide network structures, tested as anodes in lithium ion batteries, are characterized by high reversible capacity and improved stability under repeated galvanostatic cycling (J. Appl. Electrochem. 51 (2021) 815).

● The Taguchi statistical method has been proposed as an approach to conduct less resource-intensive research in the field of electrochemical device development and validated based on a study on factors affecting the intensity of the corrosion process in lithium ion batteries (Electrochim. Acta 360 (2020) 137011).

● A new in-situ analytical method combining zero-resistivity amperometry and gravimetry is proposed to study the corrosion of lithium in contact with copper. Through this method, applied to the case of Cu-Li contact corrosion in a sulfolane-based electrolyte, it was found that an adsorbed layer of polyethylene oxide on the copper surface could be applied to inhibit corrosion (Electrochim. Acta 463 (2023) 142853).

**C. Review articles**

● A methodology is developed to distinguish between Faraday, pseudocapacitive and capacitive charge storage using conventional electrochemical methods. The experimental determination of these types of charge storage is crucial for a proper understanding of the processes in various electrochemical energy storage systems (Electrochim. Acta 412 (2022) 140072).

● As a result of a thorough consideration of the corrosion mechanisms of aluminum used as an anode current collector in lithium-ion batteries and of methods to study this phenomenon, approaches to optimize electrochemical systems to limit the detrimental impact of this technological problem have been proposed (J. Energy Storage 43(2021) 103226).

● On the basis of an extensive review of methods of formation and characterization of three-dimensional copper current collectors used in various electrochemical devices (batteries, supercapacitors and electrocatalysts), special attention has been paid to the electrochemical technique of dynamic hydrogen bubbles allowing the production of three-dimensional bonded structures, also called metal foams (Energies 16 (2023) 4933).

The candidate's contributions can be defined as the enrichment and generalization of existing knowledge, as well as the development of new research methods in materials science with a view to applications in a particularly relevant practical field (lithium-ion batteries) with great potential economic impact.

The personal contribution of Assoc. Prof. Ivanov in the scientific works with which he participates in the present competition can be assessed indirectly through the place he occupies in the order of co-authors. He is the second co-author in three publications and the last co-author in the remaining three publications, equivalent to a habilitation thesis. In the other publications submitted for the competition, the candidate is first author in three publications, second author in three publications and last author in three publications. He is the sole author of one chapter of the book Corrosion and Degradation in Fuel Cells, Supercapacitors and Batteries, published by Springer. It is noteworthy that in both patent applications he is second in the order of co-authors. Considering that the first two places in the order of authors are usually occupied by the researchers with the greatest contribution, and the last place is given to the senior researcher responsible for the concept and overall conduct of the research, the personal contribution of Assoc. Prof. Ivanov in these scientific works is unquestionable.

**5. Reflection of the candidate's scientific publications in Bulgarian and foreign literature.**

So far, 1058 citations have been noted on all of Assoc. Prof. Ivanov's publications. The works with which the candidate participates in the competition for professor, all published in the last five years (2019-2024), have a total of 123 citations in publications from the last four years (2021-2024). Undoubtedly, this is a testimonial to their relevance and significance. Cited are 11 of the 14 publications included in the present competition for professor.

**6. Critical notes and recommendations to the candidate's scientific works.**

The candidate's contributions could have been formulated more precisely by focusing on the new facts and conclusions that have enriched scientific knowledge in the relevant field, without retelling the abstracts of the respective publications.

**7. Reviewer's personal impressions of the candidate.**

I know Svetlozar Ivanov since he joined IPC-BAS in 2000 and worked with him until 2010 in the field of electrochemistry of conducting polymers. Even as a young researcher he was distinguished by a very good chemical background and a thorough approach to the problems at hand. He quickly got into the work-related topics during the first ten years of his scientific career and at the end of this period was able to pose and solve scientific problems completely independently, drawing both on a broad overview of the scientific literature, on the experience of the research group at IPC and on collaboration with foreign partners. My personal impressions of his development since 2010 are mainly based on his presentations at conferences I have had the opportunity to attend. These presentations testified to the growth of an

electrochemical scientist with a wide range of experience and knowledge in different areas of materials science, skillfully using a diverse research toolbox and interacting successfully with different research groups.

**CONCLUSION**

The review of the documents submitted by Assoc. Prof. Ivanov in the competition for the professorship closes the opinion that he is a fully developed, highly qualified specialist in the field of electrochemical materials science with significant contributions in the field of electronically conductive polymers and lithium-ion batteries. The contributions highlighted from the various stages of his scientific development attest to his versatile training, ability to develop and apply new research methods, combined with the development of appropriate theoretical models. Many of the contributions in recent years are directly relevant to solving practical problems of current importance for the development of electrochemical energy storage devices.

In terms of volume, quality of scientific and applied contributions and scientific metrics, the achievements of Assoc. Prof. Ivanov fully meet and substantially exceed the legal requirements and those of the Regulations on the Conditions and Procedure for Holding Academic Positions at IPC-BAS for Acquisition of the Academic Position "PROFESSOR". On the basis of all of the above, with deep conviction and satisfaction, I recommend the distinguished members of the Scientific Jury to award to Assoc. Prof. Dr. Svetlozar Dimitrov Ivanov the academic position of "PROFESSOR" in the professional field 4.2 Chemical Sciences, specialty Physical Chemistry, for the needs of the Department "Phase Formation, Crystalline and Amorphous Materials" at the Institute. His election as a Professor would not only be a recognition of his growth as a mature scientist with high competence and a broad horizon of research activities, but also a promising opportunity to support young scientists and to contribute to thematic expansion and development in the Section "Phase Formation, Crystalline and Amorphous Materials" at IPC-BAS.

Date: 07.05.2025 г. Reviewer:

/Prof. DSc Vessela Tsakova/