

REVIEW

by Prof. Darvin Slavchev Ivanov, Ph.D.

REGARDING: competition for associate professor in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.2 Chemical Sciences, scientific specialty "Inorganic Chemistry", published in the "State Gazette" No. 89 of 24.10.2025, for the needs of the Department of Chemistry at the Faculty of Natural Sciences of the BSU "Prof. Dr. Asen Zlatarov" - Burgas.

I have been appointed as a member of the scientific jury according to Order No. RD - 4 of 5.01.2026 of the Rector of the BSU "Prof. Dr. Asen Zlatarov". I received the materials for the competition on an electronic medium.

Documents for the competition were submitted by the Senior asst. Dr. Dencho Ivanov Mihov, from the Department of Chemistry at the Faculty of Natural Sciences of the BSU "Prof. Dr. Asen Zlatarov" - Burgas.

Senior Asst. Prof. Dr. Dencho Mihov graduated from the University "Prof. Dr. Asen Zlatarov" - Burgas, chemical engineer, general education disciplines: inorganic chemistry, organic chemistry, physical chemistry, analytical chemistry, physical methods, higher mathematics, physics, informatics and professional disciplines: chemical technologies specialty "Inorganic and electrochemical productions".

In 2023 he acquired the degree of "doctor" in the scientific specialty "Inorganic Chemistry". Topic of the dissertation: "Experimental and theoretical studies of selenate systems".

Assessment of the scientific research activity of the Senior Asst. Dr. Dencho Mihov

The total number of scientific publications of the candidate is 18 (of which: 11 in Scopus and Web of Science and 3 monographs; Hirsch index, h-index = 7. The scientific publications for participation in the competition are 9, published in publications with impact factor (Web of Science) and impact rank (Scopus), (2 of them are in quartile Q1; 5 in quartile Q2 and one in quartile Q3 and Q4. 53 citations were found for the works of the candidate for the competition.

Senior Assistant Dencho Mihov has participated in 4 intra-university projects at the Research Institute of the BSU "Prof. Dr. Asen Zlatarov" and participated in 10 international and national scientific conferences.

The presented scientific works meet the quantitative criteria for holding the position of "associated professor", set out in the Regulations on the conditions and procedure for

acquiring scientific degrees and holding academic positions at the BSU "Prof. Dr. Asen Zlatarov" - Burgas.

The research conducted is up to date in view of the state of research on selenium-containing compounds as a dynamic and rapidly developing scientific direction with increasing importance for fundamental and applied science. These compounds are distinguished by an extremely rich structural diversity, determined by the flexible coordination capabilities of selenium anions and the significant influence of the nature of the coordinating metal on the formation of the crystal structure. This diversity underlies a wide range of functional properties, including magnetic, optical, nonlinear-optical, catalytic, thermal and biological characteristics.

- Study of solubility isotherms of ternary water-salt systems.

New experimental data have been obtained on aqueous solutions of selenates (a combination of alkali selenates and selenates of divalent metals - mainly from the first row of transition metals). These data are based on the study of solubility isotherms of ternary water-salt selenate systems by the Chlopin method for isothermal desaturation. When double salts are formed, their composition is determined by physicochemical analysis by the Schreinemakers method, using derivatographic analysis and X-ray phase analysis. Quantitative regularities, describing the complete state of these systems, have been derived.

- Characterization of water activity at different concentrations of the components in binary selenate solutions

The water activity for binary water-salt systems of alkaline and divalent selenates was determined by the isopiestic method, and a theoretical calculation of the solubility isotherms of the ternary systems, combinations of the corresponding binary ones, was also made. A very good match was obtained between the experimental data and the theoretically calculated ones by modeling based on the activity coefficients of the binary solutions of the starting salts.

- Thermodynamic modeling of the equilibrium in ternary water-salt selenate systems

The scientific research conducted by the Pitzer method has developed and validated thermodynamic models for the behavior of solutions and solid-liquid equilibrium in binary systems of type 1-2: $\text{Li}_2\text{SeO}_4\text{-H}_2\text{O}$, $\text{Na}_2\text{SeO}_4\text{-H}_2\text{O}$, $(\text{NH}_4)_2\text{SeO}_4\text{-H}_2\text{O}$, $\text{K}_2\text{SeO}_4\text{-H}_2\text{O}$, $\text{Rb}_2\text{SeO}_4\text{-H}_2\text{O}$ and $\text{Cs}_2\text{SeO}_4\text{-H}_2\text{O}$. Accordingly, both binary and ternary water-salt selenate systems with the participation of lithium, sodium, magnesium and nickel ions have been modeled. The equilibrium fields of crystallization of the corresponding components have been determined, and the obtained data show a very good agreement with the experimental ones.

- Characterization of the obtained double selenate salts.

Some thermodynamic characteristics of the double selenates have been determined experimentally and model-wise: isobaric molar heat capacities, entropy, enthalpy, Gibbs energy. The heat capacities of the selenates have been determined experimentally by differential scanning calorimetry for the temperature interval 298–700 K. Based on the obtained experimental results, some thermodynamic parameters for the corresponding salts have been calculated. Their osmotic coefficients and activity coefficients in solutions have also been determined.

The structures of the synthesized double selenates have been determined by quantum chemical modeling. The molecular structures and geometric parameters of the synthesized compounds were determined using Density Functional Theory, and the normal vibrations were analyzed using the DFT methodology, with subsequent determination of the characteristic absorption bands of the compounds and comparison with available data from the literature.

- The possibilities of application of the synthesized double salts of selenic acid in medicine are considered.

The obtained combined double selenate salts in smaller doses give a better cytotoxic effect, which is also confirmed by morphological observations under a phase-contrast microscope, as well as by the study of cell morphology by fluorescence for actin cytoskeleton. The zeta-potential data explain the higher cytotoxicity of cobalt-containing salts compared to those containing iron. This is explained by the fact that the particles of iron salts, although more electronegative, are much larger, and interact with the cell membrane more difficultly. On the other hand, the analysis of the zeta potential in combination with the particle size establishes that the cobalt salts are characterized by lower negatively charged and smaller particles, which is responsible for the more pronounced biological behavior towards the liver cancer cells HepG2 and the significant reduction in cell vitality.

It can be noted that the newly synthesized selenate salts based on cobalt, iron and selenium have much better pronounced cytotoxicity on liver cancer cells from the HepG2 line, compared to salts containing only one or two of the selected chemical elements.

The indicated contributions clearly reflect the original nature of the research and represent a significant contribution to the importance of oxoselenate systems.

Assessment of the teaching and learning activities of Senior Asst. Dencho Mihov

Senior Asst. Dencho Mihov in the period 1988 – 1998 was successively assistant, head assistant and senior assistant. From 1998 to 2023 he was engaged in another activity. Since 2023 he has been a senior assistant in the Department of Chemistry at the Bulgarian

State University "Prof. A. Zlatarov". His work experience at the university is 12 years. His teaching load exceeds the accepted 400 hours. His teaching activity consists of reading lectures - 15 hours and conducting practical exercises - 158 hours in the discipline "Inorganic Chemistry" and 30 hours "Stoichiometric Calculations". He conducts exercises in the discipline "General Chemistry" - 101 hours as well as in "Chemistry" - 45 for medical students. He is a co-author of 2 curricula and 4 textbooks (3 independent).

Senior assistant Dencho Mihov was a scientific supervisor of four graduate students.

Based on the above, I give a high and positive assessment of the scientific research and teaching activities of Senior Asst. Dencho Mihov.

Conclusion

The scientific research and teaching activities of Senior Asst. Dencho Mihov fully meet the qualitative and quantitative criteria for holding the position of "associated professor", set out in the Regulations on the conditions and procedure for acquiring scientific degrees and holding academic positions at BSU "Prof. Dr. Asen Zlatarov" - Burgas.

I propose to the esteemed jury to vote positively for the election of Senior Asst. Dencho Mihov to the academic position of "associated professor" in the scientific specialty "Chemistry", professional direction 4.2. Chemical Sciences, field of higher education 4. Natural Sciences, Mathematics, Informatics for the needs of the Department of "Physiology, Pathophysiology, Chemistry and Biochemistry" at the Faculty of Medicine of BSU "Prof. Dr. Asen Zlatarov" - Burgas.

19.02.2026

Sofia

Reviewer:

(Prof. Darvin Ivanov)