

REVIEW



Call for Applications for the Academic Position of "Professor" in the Professional Direction of 4.2 - Chemical Sciences, with a Specialization in Electrochemistry, Issued by the Institute for Physicochemical Research "Academician R. Kayshev" of the Bulgarian Academy of Sciences (BAN), in Issue No. 44, dated May 20, 2022.

Candidate: Jenia Stefanova Georgieva, PhD, Associate Professor (full name, academic degree, academic position);

Reviewer: Georgi Vyacheslavovich Avdeev, PhD, Associate Professor (full name, academic degree, academic position)

1. General information and brief biographical details of the candidate

Associate Professor Dr. Jenia Stefanova Georgieva was born on November 19, 1965, in Sofia. She completed her higher education at the Higher Institute of Chemical Technology – Sofia in 1993, earning a Master's degree in Electrochemistry and Corrosion. In 2008, while working at the Institute of Physical Chemistry "Acad. R. Kaishev" (IPC) of the Bulgarian Academy of Sciences (BAS), she defended her doctoral dissertation, "Chemical Deposition of Ni-Cu-P and Ni-Sn-P Coatings," and was awarded a PhD in Electrochemistry (Professional Field 4.2: Chemical Sciences). Her professional career began in 1999 as an Assistant at IPC-BAS, and following a successful competition in 2011, she was appointed to the academic position of Associate Professor at the same institute. Her total professional experience spans 40 years, the majority of which has been dedicated to scientific research in electrochemistry and corrosion. Her primary scientific interests include nanostructured materials, electrocatalysis, photoelectrocatalysis, and the chemical deposition of metals and alloys. To enhance her expertise, she has participated in several specializations and scientific collaborations at prestigious European research centers, such as Aristotle University of Thessaloniki (Greece), the Free University of Brussels (Belgium), the Center for Electrochemical Surface Technologies (CEST) in

Austria, and the Institut Charles Gerhardt Montpellier (France). Her research findings have been published in over 55 articles in renowned international journals, 51 of which are indexed in Scopus. Her work has garnered more than 1,607 citations, resulting in an h-index of 25. Additionally, she has authored a chapter in a book published by a prestigious international publishing house. Her scientific contributions have been showcased at numerous international conferences through over 20 presentations, including several invited talks. Associate Professor Georgieva has participated in 16 international and 8 national research projects, serving as the principal investigator for 4 highly-rated initiatives. Beyond her research, she is a dedicated lecturer and mentor. She delivers a course on Applied Electrochemistry at the doctoral training center and has successfully supervised a doctoral candidate through to their dissertation defense.

2. Detailed overview of the submitted documentation. Compliance with all legal regulations, including national minimum standards, as established by the BAS framework and the specific requirements stipulated by the Scientific Council of IPC in accordance with Appendix No.1.

The competition submission documentation comprises a total of 20 scientific papers. Of these, 18 have been published in international peer-reviewed journals with an impact factor (IF), while the remaining 2 have an SJR value without an IF and are indexed in the Scopus database. The distribution of the materials is as follows: Under Indicator V4, 8 publications have been reported, all of which constitute habilitative work, with 6 classified in category Q1 and 2 in Q2. In category G7, 12 articles from specialized journals are listed that were not used to obtain prior academic degrees or positions (Doctor, Doctor of Sciences, and Associate Professor). This group includes 7 publications in Q1, 1 in Q2, 2 in Q3, and 2 with SJR indexation in Scopus but without an impact factor.

The candidate demonstrates significant engagement in research initiatives, as evidenced by their participation in 4 national and 5 international scientific or educational projects (Indicators E14 and E15). Their leadership experience is further highlighted by heading one national project and leading the Bulgarian team in two international projects (Indicators E16 and E17). Under the candidate's leadership, project funding totaling 36,594.00 BGN has been secured (Indicator E18). A

comprehensive overview of the attached documentation has been provided, detailing the specific competition criteria and the methodology applied to assess scientific contributions. All formal prerequisites have been satisfied, including the minimum national requirements, in full compliance with the regulations of the BAS and the standards established by the Scientific Council of IPC according to Appendix No.1.

3. A comprehensive overview of the candidate's scientific research and practical application activities

The candidate's scientific career is distinguished by its intensity and significant achievements. Their doctoral dissertation focuses on the chemical deposition of Ni-P coatings, which provide exceptional uniformity, hardness, and corrosion resistance despite their technological complexity. These alloys are essential in magnetic disk production, automotive manufacturing, electronics, and the food and beverage industries. Recent technological advancements require the optimization of these functional layers through the incorporation of a third element, such as copper, tin, antimony, or boron. Ternary systems like Ni-Cu-P and Ni-Sn-P outperform binary systems by maintaining their amorphous structure and paramagnetic properties at elevated temperatures. Specifically, copper enhances protective qualities, while antimony improves bonding capabilities. The candidate's material studies offer new insights into the nickelation mechanism and the role of additives, providing significant practical contributions. Furthermore, the candidate has developed and proposed novel electrolytic cells for the deposition of Ni-Cu-P and Ni-Sn-P alloys, while investigating the effects of pH and complexing agents on their deposition rates and microstructures.

Publications equivalent to the habilitation for an associate professorship investigate the synthesis and optimization of innovative photocatalytic materials, specifically electro-deposited TiO_2 and WO_3 coatings. A methodology was developed for the potentiostatic electrosynthesis of multilayer titanium oxide coatings on stainless steel. Their properties were thoroughly characterized, and modifications were applied to the composite coatings to enhance charge carrier separation and broaden the absorption spectrum through cooperative effects. Performance improvements were also achieved by doping the photocatalysts with La_2O_3 , resulting in characteristics that rival those of industrial-grade electrodes. Non-qualification research further addresses

photocatalysis, including the development of a novel photoelectrochemical cell for the oxidation of organic vapors under UV and visible light. This work successfully realized a gas-phase reaction using a polymer electrolyte with a TiO_2 photoanode and synthesized highly efficient TiO_2/WO_3 structures for air purification. The influence of the photoanode composition ($\text{TiO}_2/\text{WO}_3/\text{C}$) on the photocurrent within a solid-state cell was investigated. TiO_2/WO_3 layers deposited on stainless steel for the degradation of 4-chlorophenol were analyzed, and a review focusing on two-component oxide photoanodes for the oxidation of organic compounds was prepared. Furthermore, the corrosion resistance of Ni-Cu-P coatings integrated with TiN layers was examined. The research conducted by the candidate is substantial and addresses critical environmental and material challenges. The results demonstrate the high efficiency and stability of the developed systems—matching or exceeding commercially available alternatives in certain instances—thereby highlighting their potential for practical application. Additionally, the candidate has received significant recognition from the scientific community, with publications in prestigious international journals attesting to the originality and scholarly contribution of the research.

4. Key scientific contributions

In recent years, the candidate's research has focused on the development and characterization of nanostructured materials for electrocatalysis and photoelectrocatalysis in fuel cells and electrolyzers. A central priority has been establishing the relationships between catalyst structure and performance in electrochemical processes. A significant contribution involves the application of sustainable synthesis methods—such as photochemical reduction and galvanic replacement—leveraging expertise in electroless deposition. These approaches enable precise control over the composition and distribution of active components during electrocatalyst design. Experimental data confirm that hybrid synthesis methods yield core-shell particles, which significantly reduce platinum consumption while maintaining high efficiency. By fine-tuning synthesis parameters, the electronic properties and platinum alloying characteristics can be effectively modified. Furthermore, the application of galvanic replacement has been extended to nanoscale supports and semiconductor oxides, facilitating the fabrication of functional structures with optimal dispersion.

She has established correlations between the structures and activities of materials in key electrochemical reactions. We also investigated the influence of electronic effects and interfacial interactions on the catalytic properties and stability of these systems.

These publications align with the competition theme and electrochemistry priorities, contributing to the theoretical advancement and practical application of novel catalysts for energy efficiency and sustainability. The research comprises three distinct areas regarding the synthesis and characterization of new materials: catalysts for the electrocatalytic oxidation of methanol; the synthesis and characterization of materials for oxygen-involved electrocatalytic reactions (ORR and OER); and the investigation of electrocatalytic and photo-electrocatalytic processes occurring on oxide supports and composite materials.

4.1. Materials for the electrocatalytic oxidation of methanol (MOR)

These studies delineate the relationships between the structure, composition, and properties of platinum catalysts in the methanol oxidation reaction (MOR). It has been demonstrated that their performance depends on the interactions between the active phase, the carbon component, and the oxide support. Key factors governing catalytic activity and resistance to CO poisoning have been identified. Specifically, the Pt(Cu)/C and Pt(Ni)/C systems, which exhibit a core-shell structure when prepared via galvanic replacement, have been extensively investigated. (*B 4.1–B 4.3, F 7.12*).

When TiO₂ is utilized as a support, Pt(Ni)/TiO₂ and Pt(Ni)/TiO₂-C structures are formed. These configurations demonstrate improved activity resulting from their interactions with titanium dioxide. (*F 7.2*). Analysis of composites comprising WO₃ and TiO₂/WO₃ demonstrates that semiconductor carriers optimize electronic properties and facilitate the photoinduced removal of CO from the surface. (*F 7.1, F 7.6*).

By employing integrated methodologies, bimetallic Pt(Ni) and Pt(Cu) catalysts were synthesized on oxide, carbon, and mixed supports. The transition metals enhance the MOR activity by inducing geometric and electronic modifications in platinum. The Pt(Cu)/TiO₂ systems demonstrate six times the activity of conventional Pt/C catalysts, attributed to a stabilized core-shell structure and synergistic interactions with the support. (*F 7.4, F 7.5*).

The Pt-TiO₂-C composites exhibit high stability, and UV light enhances their activity by 25% by generating surface-active OH radicals. (B 4.7). The addition of transition metals and oxides weakens the interaction with CO, as evidenced by the reduced oxidation potential of CO.(B 4.1, B 4.3, *Γ* 7.2, *Γ* 7.4, *Γ* 7.12).

The research conducted on this subject elucidates the mechanisms through which catalytic stability and CO-tolerance are enhanced by metal-support interactions. Methods have been developed to synthesize highly efficient nanoscale catalysts with minimal platinum content. These findings underscore the potential of hybrid systems to overcome the limitations of conventional catalysts and provide a solid foundation for further research in the field of electrocatalysis. The studies performed have received positive feedback and have been extensively cited in scientific literature.

4.2. Synthesis and characterization of novel materials for oxygen-involved electrocatalytic reactions (ORR and OER).

In this research field, efforts are focused on developing nanostructured electrocatalysts with reduced noble metal content and elucidating the relationship between their synthesis, structure, and activity. A primary priority is the refinement of methods for the controlled fabrication of bimetallic catalysts, as described in subsequent publications building upon foundational work. This includes the application of chemical precipitation via galvanic exchange on oxide supports, photochemical synthesis, and the development of catalysts for oxygen-based processes.

Synthesized Pt-based electrocatalysts on oxide supports, with investigation of the effect of the support on the active phase and its associated parameters. Using chemical deposition and galvanic replacement, Pt(Ni) systems on TiO₂ and TiO₂-C were successfully prepared (publication *Γ* 7.2). In this case, the contact between the platinum and the oxide determines the catalytic activity. The same approach has been applied to nanoscale Pt(Cu)/TiO₂ systems synthesized via photochemical deposition. (publication *Γ* 7.4). This enables precise particle shaping and conservation of precious metals. The studies have been complemented by analysis of PtCu@TiO₂, which elucidates the relationship between the structure of the active phase and its electrocatalytic activity.(publication *Γ* 7.5).

Oxidation supports significantly influence the stability and electronic properties of catalytic systems. This is evidenced by bilayer TiO₂/WO₃ structures modified with Pt, which demonstrate enhanced activity in methanol oxidation

((Publication Γ 7.6). Additionally, TiO_2 nanotubes modified with nitrogen and boron have been developed to improve photoelectrochemical performance (Publication G 7.3). These results build upon the methodology established in foundational research for preparing bimetallic catalysts—utilizing oxide supports and photochemical techniques—to achieve superior efficiency and controlled architectures.

Nanostructured catalysts have been extensively researched, and bimetallic systems for the oxygen reduction reaction (ORR) have been synthesized through innovative methodologies. By chemically depositing copper (Cu) or cobalt (Co) onto a carbon substrate followed by galvanic exchange with platinum (Pt), Pt–Cu/C and Pt–Co/C catalysts were successfully developed. These systems feature reduced precious metal content alongside enhanced catalytic performance. It has been established that in the Pt–Cu/C system, copper modulates the electronic state of platinum, thereby accelerating the ORR. Consequently, Pt–Cu/C achieves a specific activity 56% higher than that of the standard Pt/C catalyst at 0.85 V (RHE). The synthesized Pt–Co/C catalysts (0.7 wt.% Co) exhibit a core–shell structure. Despite a lower active surface area, they demonstrate 2.6 times higher mass activity and 4 times higher specific activity compared to the standard Pt/C catalyst (Publication V 4.8). This confirms that costs can be minimized through platinum savings while maintaining high catalytic efficiency.

To optimize oxygen evolution reaction (OER) performance, highly dispersed $\text{IrO}_2/\text{TiO}_2$ systems have been developed. Through photochemical deposition, IrO_2 nanocrystals with dimensions of 1–2 nm were synthesized on TiO_2 supports at a 25 wt% Ir loading. These materials demonstrate catalytic activity comparable to pure IrO_2 while significantly reducing noble metal consumption. Research findings in publications V 4.5 and V 4.6 indicate that the synergy between the active phase and the support enhances both current density and stability, rendering these catalysts highly effective for water photoelectrolysis.

The obtained results can be summarized as follows:

A strategic approach has been established for synthesizing nanoscale electrocatalysts with reduced noble metal content by precisely tailoring the active phase and strengthening metal–support interactions. Through photochemical methods on oxide substrates, highly dispersed platinum catalysts with superior performance have been

synthesized. The specific roles of TiO_2 and WO_3 supports in enhancing the dispersion, stability, and catalytic activity of the active components have been elucidated. Furthermore, optimized designs for Pt–Cu/C, Pt–Co/C, and $\text{IrO}_2/\text{TiO}_2$ systems targeting the ORR and OER have been developed, achieving significant reductions in precious metal loading alongside improved performance metrics. These findings define a clear research direction for engineering highly efficient electrocatalysts through the precise modulation of their structural and electronic properties.

4.3 Study of electro-and photoelectrocatalytic processes occurring in oxide supports and composite materials

In addition to preparatory efforts, this research focuses on electrocatalytic and photoelectrocatalytic metal-oxide systems. The primary objective is to elucidate the relationship between material structure, charge transfer, and catalytic performance. Innovative approaches have been developed for modifying TiO_2 and WO_3 , as well as for synthesizing composites with controlled interphase interactions. These efforts build upon established methodologies for creating nanoscale electrocatalysts by adapting them to semiconductor substrates and photochemical reactions. Furthermore, a new methodology for the quantitative analysis of TiO_2 anode activity using electrochemical impedance spectroscopy has been established. This approach distinguishes the influence of specific surface area from catalytic properties, enabling an objective comparison of photoanodes. It has been determined that TiO_2 nanotubes degrade chloramphenicol more effectively than sol-gel layers, as their expanded surface area compensates for their lower intrinsic activity.

The synergistic effect between photo- and electrocatalytic processes in TiO_2 and WO_3 systems was analyzed, with particular emphasis on the role of charge carriers. By doping with nitrogen and boron, TiO_2 nanostructures were synthesized, exhibiting an optimized electronic architecture and enhanced photoelectrochemical performance. A theoretical model for the synthesis of Pt(Cu)/ TiO_2 composites was also presented, confirming the pivotal role of Ti(III)/Ti(IV) redox transitions in stabilizing the metallic phase. It was demonstrated that the metal–oxide interface governs both structural parameters and catalytic activity. A strategy was developed to tune catalytic performance by combining semiconductor oxides, metal nanoparticles, and photochemical synthesis. The conducted studies are comprehensive, combining the development of innovative nanostructure synthesis methods with an exploration of

their potential for practical application as modern tools in analytical monitoring. This research area represents a significant scientific challenge that has garnered increasing attention from the research community in recent years. The achieved results possess both fundamental and practical scientific value, contributing to scientific innovation and expanding the existing body of knowledge.

5. A review of the candidate's scientific publications in Bulgarian and international literature

Based on data from Scopus, Associate Professor Zhenya Georgieva has published 51 scientific papers. In total, 49 of these works have been cited 1,629 times by independent sources, yielding an h-index of 25. She holds the position of lead author in over 40% of her publications, the majority of which were completed in partnership with foreign research teams. Four of her articles have each received over 110 citations. Given these achievements, meeting the requirements of the "Group D" indicator set is entirely straightforward. These results demonstrate high international visibility and recognition of its scientific contributions in the fields of catalysis and energy materials.

6 . Critical notes and recommendations for the scientific works of the candidate

I don't have any.

7 . Personal impressions of the candidate by the reviewer

I have known Associate Professor Georgieva since 2007 and have had the opportunity to observe her professional development and scientific achievements over the years. She is a highly competent and dedicated researcher who has made clear and significant contributions to her field. Her consistent, high-quality work makes her an excellent candidate for the academic position for which she is applying.

CONCLUSION

Based on the competition materials, the submitted scientific contributions, and my own observations, I can conclusively state that Associate Professor Dr. Zhenya Georgieva meets the criteria established by the Law on the Development of the Academic Staff of the Republic of Bulgaria and its implementing regulation. The application fully complies with the requirements of the Bulgarian Academy of Sciences, as well as the specific regulations and decisions of the Scientific Council of IPC-BAS regarding academic appointments. Consequently, I cast a favorable vote for

the Scientific Council of IPC-BAS to appoint Associate Professor Dr. Jenia Georgieva to the academic position of "Professor".

Дата 24.09.2026 г.

Reviewer

Associate Professor Dr.

Georgi Avdeev