REVIEW STATEMENT

by Dr. Ivaylo Georgiev Tankov

Associate Professor at Burgas State University "Prof. Dr. Assen Zlatarov",
Higher Education Field 4 (Natural Sciences, Mathematics and Informatics), Professional Field 4.2 (Chemical Sciences), Scientific Specialty Chemical Kinetics and Catalysis.

regarding the competition for the academic position of "Associate Professor" in Higher Education Field 4 (Natural Sciences, Mathematics, and Informatics), Professional Field 4.2 (Chemical Sciences), scientific specialty "Solid State Chemistry" (01.05.18) at the Institute of Catalysis – BAS, published in the State Gazette, Issue 58 of June 26, 2026, No. 182.

1. Overview of the procedure

This review has been prepared pursuant to Order No. RD-09-42 dated 28 August 2026 issued by the Director of the Institute of Catalysis – BAS; in accordance with Articles 4 and 29a of the Act on the Development of the Academic Staff in the Republic of Bulgaria, Article 2 of the Regulations for its implementation, Article 12, Paragraph 4 of the Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and Holding Academic Positions at BAS, and Article 60 of the Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and Holding Academic Positions at the Institute of Catalysis – BAS; and based on the decision of the Scientific Council of the Institute of Catalysis – BAS (Minutes No. 11 dated 19 November 2026).

2. General characteristics of the research activity of the candidate

The candidate's scientific work focuses on the study of solid-state materials intended for use under radiation and corrosive conditions. The research topic is timely and addresses the development and characterization of materials with enhanced resistance to extreme conditions, including radiation, thermal, and corrosive loads. The candidate's scientific output comprises 59 publications with 357 citations in Scopus. For the current competition, 19 publications have been submitted, 18 of which appeared in international peer-reviewed journals with an impact factor. Sixteen of these were published in journals ranked in the first quartile (Q1). The candidate reports 84 citations (excluding self-citations) and an h-index of 10. Eight publications are included in the habilitation section, with an additional eleven presented outside of it. The submitted scientific output demonstrates consistent research activity and significant international visibility of the results obtained.

3. Major scientific contributions

The scientific concept underlying the presented research can be formulated as an investigation of the following chain of dependencies: **radiation/corrosion impact → defect structure → microstructural changes → functional properties → assessment of application potential**. The use of a comprehensive experimental and theoretical approach is particularly noteworthy. The various studies combine positron spectroscopy, X-ray and neutron diffraction, Raman spectroscopy, electron microscopy, spectroscopic methods, and computational approaches, including density functional theory (DFT) and molecular dynamics.

3.1. Radiation-resistant materials

A significant portion of the scientific contributions relates to the study of tungsten and other materials with potential applications in nuclear and thermonuclear energy. Research on W and Fe-Cr systems has focused on radiation-induced vacancy defects and their role in hydrogen and helium retention and subsequent structural degradation. In modified tungsten systems—specifically W–(Ta, V, Cr, Ti) and W–TiC—relationships have been established between chemical composition, microstructure, and radiation resistance. Certain compositions exhibited increased hardness and reduced surface defect formation upon irradiation with He+ ions. Studies on W–B4C–TiC–C and B4C complement this work by analyzing structural changes and the radiation stability of boron and carbide phases. The results are significant for assessing the behavior of these materials under radiation exposure. In the case of WC–6Co, the impact of heavy ions on the surface layer was investigated, covering phenomena such as amorphization, the formation of new phases, and the development of vacancy complexes and grain-boundary defects.

3.2. Behavior under gamma irradiation

Another significant result concerns the ZrB_2 and TiN systems. In the case of ZrB_2, the formation of monovacancies and vacancy complexes upon gamma irradiation was observed, as well as their subsequent reorganization during thermal treatment. For TiN, the evolution of defects—from monovacancies to more complex vacancy complexes—and their interaction with grain boundaries were tracked. These results are important for elucidating the mechanisms of radiation damage and structural recovery, enabling a correlation to be established between the irradiation dose, defect type, and changes in properties. Studies on ZrB_2 are of particular interest; they compared the effects of heavy ions and gamma radiation and monitored the subsequent thermal recovery. A reduction in the amorphous phase and an increase in the degree of crystallinity were observed following thermal treatment.

3.3. "Defect engineering" and functional materials

Research on $BiVO_4$ represents a significant scientific focus. Through phosphorus doping and the use of a combination of experimental and computational methods, various types of defects were identified, including oxygen and bismuth vacancies as well as antisite defects. The relationship between the defect structure, electronic and optical properties, and photocatalytic behavior was investigated. These studies contribute to the "defect engineering" approach, in which defects are viewed not merely as an undesirable consequence of service conditions, but as a means to purposefully modify the material's functional characteristics. For W–Ni alloys, an explanation of radiation resistance has been proposed—based on molecular dynamics calculations, DFT, and experimental methods—in terms of rapid defect recombination and the role of interfaces as defect sinks.

4. Corrosion-resistant materials

The second major group of scientific results concerns Ti(C,N)-based coatings and their modifications. TiZrSiCN and TiZrNbCN systems were investigated, establishing a relationship between composition, structure, and corrosion behavior. The addition of Si was found to enhance corrosion resistance, whereas localized pitting corrosion was observed at specific Nb content levels. A notable strength of the work is the combined use of positron spectroscopy, DFT, Raman spectroscopy, SEM, and optical profilometry. This approach enables the exploration of interrelationships between electronic structure, defects, morphology, and corrosion characteristics. The presented results lend scientific and practical significance to this section, as they focus on evaluating promising coatings for service in demanding radiation and corrosive environments.

5. Methodological contribution

The adaptation of cryogenic equipment for neutron diffraction—enabling operation at temperatures below 2 K and the real-time monitoring of magnetic phase transitions—merits special mention. This result is primarily methodological and engineering-oriented in nature, expanding the experimental capabilities for investigating materials at low temperatures.

6. Assessment and critical remarks

The primary merit of the presented scientific work lies in the comprehensive nature of the research and the systematic analysis of the relationships between defects, structure, and material properties. The scientific work is not limited to merely recording structural changes; in many instances, it aims to elucidate the mechanisms underlying the formation, migration, interaction, and recovery of defects. A positive aspect worth noting is the diversity of materials investigated—including metallic and ceramic systems, composites, coatings, and functional materials. However, the presentation of the research contributions could be improved. In some places, the obtained results, the scientific novelty, and the scientific-applied significance are conflated. For greater clarity, it is recommended that each contribution be formulated in terms of: (*i*) an established fact, (*ii*) scientific novelty, (*iii*) a mechanism, and (*iv*) significance. Overly categorical statements regarding a material's applicability should also be avoided. A more substantiated approach is to state that the results "support the potential" or "identify the material as a promising candidate" under the specific conditions investigated.

7. Fulfillment of requirements for the academic position of "Associate Professor"

The candidate's report on meeting the minimum national requirements—as well as the requirements set forth in the Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and Occupying Academic Positions at the Institute of Catalysis (BAS) for the position of "Associate Professor" in professional field 4.2 "Chemical Sciences"—demonstrates that the candidate's achievements satisfy the necessary criteria for the position of "Associate Professor" in the specified professional field.

Table 1. Group of indicators for appointment to the academic position of "Associate Professor".

Group of indicators	Minimum national requirements	Minimum requirements of IC–BAS	Candidate's points
А – Indicator 1	50	50	50
Б – Indicator 2	–	–	–
В – Indicator 3 или 4	100	100	167
Г – Sum of indicators from 5 to 9	200	220	275
Д – Sum of indicators from 10 to 12	50	60	166
Е – Sum of indicators from 13 to 23	–	–	–

8. Conclusion

The scientific output presented by the candidate is characterized by relevant research topics, a significant volume of publications, and the use of modern experimental and theoretical methods. The primary focus of the research lies in establishing the relationship between radiation and corrosion effects, defect structure, microstructural evolution, and the functional properties of solid-state materials. The contributions can be summarized in several key areas: (i) identification and characterization of radiation-induced defects in promising materials; (ii) elucidation of the mechanisms governing defect formation, accumulation, migration, and recovery; (iii) establishing links between chemical composition, microstructure, and radiation/corrosion resistance; (iv) application of defect engineering approaches to modify functional properties; (v) development and

implementation of comprehensive experimental and computational methodologies; (vi) generation of scientific and applied results for the evaluation of candidate materials intended for use under extreme conditions; and (vii) an engineering-methodological contribution involving the adaptation of cryogenic equipment for neutron research.

In summary, the presented scientific work holds clear scientific and applied value and aligns with the scope of professional field 4.2 "Chemical Sciences," specializing in "Solid-State Chemistry." I believe that the scientific results, publication record and the nature of the contributions justify a positive assessment of this candidacy within the competition for the academic position of "Associate Professor."

24.09.2026 Member of the scientific jury:

/Assoc. Prof. Dr. Ivaylo Tankov/