R E V I E W

by Prof. Hristo Gospodinov Kolev, PhD, Institute of Catalysis at the Bulgarian Academy of Sciences, member of the Scientific Jury appointed by Order No. RD-09-42/28 August 2026 of the Director of the Institute of Catalysis – BAS and designated as a reviewer by a decision of the Scientific Jury adopted at its first meeting held on 8 September 2026 (Minutes No. 1), regarding the materials submitted by Assistant Professor Evgeni Petrov Popov, PhD, for participation in the competition for the academic position of Associate Professor in professional field 4.2. Chemical Sciences, scientific specialty "Solid State Chemistry", for the needs of the Laboratory of Design and Characterization of Catalytic Materials, thematic area "Surface Analysis", at the Institute of Catalysis – BAS, announced in the State Gazette, Issue 58 of 26 June 2026, Announcement No. 182.

1. General Presentation of the Submitted Materials

The sole candidate in the announced competition is Assistant Professor Evgeni Petrov Popov, PhD, from the Institute of Catalysis at the Bulgarian Academy of Sciences. The set of documents submitted by the candidate was examined by the committee appointed by Order No. RD-09-41/19 August 2026, and Dr Popov was admitted to participate in the competition.

The submitted materials comply with the requirements of Article 24 of the Development of the Academic Staff in the Republic of Bulgaria Act, Articles 53 and 54 of the Regulations for its implementation, and Articles 44 and 47 of the Regulations on the Terms and Procedure for Acquiring Academic Degrees and Holding Academic Positions at the Institute of Catalysis – BAS.

The candidate's overall scientific output comprises 59 publications, 10 of which are related to his doctoral dissertation. For participation in the present competition, Dr Popov has submitted 19 scientific publications that do not overlap with the works used for acquiring the educational and scientific degree of Doctor. Eight publications are included under group of indicators "V" as works equivalent to a habilitation thesis, while eleven are submitted under group of indicators "G" as scientific works outside the habilitation thesis.

The candidate has submitted the required administrative documents, curriculum vitae, lists of scientific publications and citations, a report on compliance with the minimum national requirements and the additional requirements of the Institute of Catalysis – BAS, habilitation and author's reports on the scientific contributions, as well as the corresponding supporting evidence.

2. Brief Biographical Information about the Candidate

Assistant Professor Evgeni Petrov Popov, PhD, graduated from Sofia University "St Kliment Ohridski" with a Master's degree in Physics and a specialization in Nuclear and Elementary Particle Physics. From 2008 to 2013, he was a doctoral student at the Institute for Nuclear Research and Nuclear Energy at BAS, where he prepared a dissertation entitled "Modelling of Positron Interactions in Condensed Matter Used in ITER" and acquired the educational and scientific degree of Doctor.

His professional career began at the Institute for Nuclear Research and Nuclear Energy at BAS, where he successively held the positions of physicist, Assistant and Assistant Professor. During this period, his scientific work was primarily focused on modelling positron annihilation and investigating defects in materials intended for use in the ITER fusion reactor. From 2017 to 2025, he also worked at the Institute of Solid State Physics at BAS, where he conducted research on the structure of condensed matter and applied density functional theory methods.
Since 2018, his scientific activity has also been associated with the Joint Institute for Nuclear Research in Dubna, Russian Federation. He initially worked at the Frank Laboratory of Neutron Physics, where he participated in real-time structural studies using neutron diffraction. Since 2022, he has held the position of Senior Research Scientist at the Dzhelepov Laboratory of Nuclear Problems, with a primary focus on investigating structural defects in materials by means of positron spectroscopy.
Since July 2025, Dr Popov has held the academic position of Assistant Professor in the Laboratory of Design and Characterization of Catalytic Materials at the Institute of Catalysis – BAS, research group "Surface Analysis". His principal activities include investigating structural defects in materials using positron spectroscopy and neutron diffraction and applying these methods to the characterization of materials intended for various functional applications.
His education, extensive research experience and consistent work in the fields of condensed matter physics, solid-state materials, and methods for studying their structural and surface defects demonstrate that Dr Popov possesses the necessary professional qualifications and meets the formal requirements for participation in the competition.

3. Evaluation of the Candidate's Scientific and Applied Research Activities

For participation in the competition, Assistant Professor Evgeni Popov has submitted 19 scientific publications referenced and indexed in the internationally recognized Web of Science and Scopus databases. Sixteen of them were published in Q1 journals, one in a Q2 journal, one in a Q4 journal, and one in a publication with an SJR indicator but without an assigned quartile. Eight publications are included in the habilitation thesis under group of indicators "V", while the remaining eleven are submitted as scientific works outside the habilitation thesis under group of indicators "G".
Under indicator "A", the candidate receives the required 50 points for the acquired educational and scientific degree of Doctor. The eight publications submitted as equivalent to a habilitation thesis provide 167 points under group of indicators "V", compared with the minimum requirement of 100 points. The eleven publications outside the habilitation thesis provide 275 points under group of indicators "G", compared with the minimum requirement of 220 points.
At the time of submitting his documents, the candidate reported 83 citations of the publications included in the competition, providing 166 points under group of indicators "D", compared with the minimum requirement of 60 points. The substantial excess is particularly pronounced for the citation indicator and demonstrates the recognition and scientific impact of the published results.
The candidate's total score under groups of indicators "A", "V", "G" and "D" is 658 points, compared with the minimum requirement of 430 points. The minimum requirements are fulfilled

separately for each mandatory group, with the requirements under groups “V”, “G” and “D” exceeded by 67, 55 and 106 points, respectively.

The presented quantitative indicators demonstrate substantial publication activity, a predominant presence of scientific works in journals belonging to the highest Q1 quartile, and convincing citation of the obtained results. Based on the submitted report, I conclude that Assistant Professor Evgeni Popov fulfils the minimum national requirements and the additional requirements of the Institute of Catalysis – BAS for holding the academic position of Associate Professor in professional field 4.2. Chemical Sciences, scientific specialty “Solid State Chemistry”.

4. Scientific and Applied Research Contributions

The scientific output submitted for the competition comprises 19 publications, eight of which constitute the habilitation thesis under indicator “V”, while eleven are submitted under indicator “G”. The studies are interdisciplinary and combine methods from condensed matter physics, materials science and radiation physics. The candidate’s principal scientific expertise is associated with the use of positron annihilation and theoretical calculations to characterize vacancies, vacancy clusters and other defects in solid-state materials. This methodology is combined with X-ray and neutron diffraction, electron microscopy, spectroscopic methods and computer modelling.

The scientific and applied research contributions can be grouped into the following principal areas:

The first area comprises theoretical modelling and experimental investigation of defects in materials intended for operation in radiation environments. Calculations based on density functional theory were used to determine positron lifetimes and momentum distributions for different types of defects in tantalum, α-Fe and Fe–Cr alloys containing hydrogen and helium. The obtained relationships allow more reliable interpretation of experimental positron spectra and identification of vacancies and vacancy complexes. These results are relevant to the assessment of materials used under nuclear fusion conditions, where the accumulation of hydrogen, helium and radiation-induced defects is among the principal causes of changes in their structure and properties.

A substantial part of the research is devoted to the radiation resistance of ZrB_2 and TiN. Positron annihilation spectroscopy, Doppler broadening of the annihilation line and theoretical calculations were used to follow the formation, growth and recombination of monovacancies and vacancy clusters after gamma irradiation and subsequent thermal treatment. The dose limits within which the materials retain their functional characteristics were established, along with the possibilities for partial structural recovery through thermally activated migration and recombination of defects. Particular attention was paid to the behaviour of boron and zirconium vacancies in ZrB_2 and titanium vacancies in TiN. The obtained results contribute to the assessment of these materials as candidates for applications in reactor and space environments.

A second group of contributions is associated with the investigation of tungsten- and boron-carbide-based materials and composites under ion irradiation. Structural changes were monitored in W_2B produced by mechanical alloying of W, B_4C, TiC and graphite, as well as in the WC–6Co hard alloy under helium- and heavy-ion irradiation. The formation of defect clusters in B_4C was investigated, and its potential use as a component of radiation-resistant materials was analysed.

The results demonstrate that irradiation leads to complex defect reorganization, changes in the crystalline and partially amorphous structure, and redistribution of carbon. Studies of W–VC–C and W–Ni systems further clarify the role of phase boundaries as sites for the absorption and recombination of radiation-induced defects. It was shown that controlling the phase composition and interfacial structure may provide a better balance between radiation resistance and structural stability.

This area also includes the investigation of HDPE/SiO_2 nanocomposite films under high-dose gamma irradiation. Intermediate SiO_2 concentrations were found to provide the best radiation resistance, while the interfaces between the polymer matrix and the nanoparticles acted as positron-trapping sites. This result demonstrates the applicability of positron methods not only to metallic and ceramic materials but also to polymer nanocomposites, in which free volume and the state of the interfaces determine their performance characteristics.

The third scientific area encompasses multicomponent carbonitride coatings and composite ceramics. The influence of the C/N ratio on the structure, mechanical properties and corrosion resistance of Ti-based carbonitride coatings was investigated. The role of Si and Nb additions under proton irradiation was analysed, and the Si-containing coating was found to provide the best combination of structural stability and corrosion protection. Defects and interfacial interactions in multicomponent TiZrCN-based coatings were characterized by examining the free volume and electron momentum density. In the Al_2O_3–YSZ composite system, the influence of high hydrostatic pressure on the distribution and agglomeration of ZrO_2 grains was established, and conditions were identified for obtaining a structure with high density and improved mechanical properties.

The investigation of P^+-implanted $BiVO_4$ thin films is of particular relevance to the thematic profile of the Institute of Catalysis – BAS. Depth profiling with a slow positron beam, combined with theoretical calculations, was used to identify oxygen, bismuth and vanadium vacancies and their complexes. It was demonstrated that the controlled introduction of defects modifies the electronic structure, optical band gap and charge transport. At an appropriate implantation level, defects may facilitate the separation and transport of photogenerated charge carriers, whereas an excessive defect concentration increases carrier scattering and non-radiative recombination losses. These results are directly relevant to the optimization of photocatalytic and photoelectrochemical materials and to the course of oxidation processes.

The submitted works also contain a distinct engineering and methodological line associated with the design and adaptation of a cryogenic device for neutron diffraction studies of structural and magnetic phase transitions at temperatures below 2 K. This development expands the possibilities for investigating materials under extreme conditions and demonstrates that the candidate’s competence is not limited to theoretical calculations and data processing but also includes solving specific experimental and engineering problems.

The scientific publications result from extensive international cooperation, and many of them involve large teams of authors. This makes it difficult to distinguish the individual contribution entirely unambiguously solely on the basis of the author’s report. Nevertheless, the candidate’s

position in the lists of authors and the published author contribution statements demonstrate his participation in the methodology, theoretical calculations, experimental investigations, interpretation of the results, manuscript revision and, in individual cases, acquisition of funding. The candidate is the first author of two publications and the corresponding author of one of the principal studies on ZrB_2. A number of publications explicitly identify his contributions to conceptualization, methodology, software calculations, investigation and analysis of the results. I therefore conclude that his personal contribution is substantial and complies with the requirements for holding the academic position of Associate Professor.

I consider the application of Dr Popov's expertise at the Institute of Catalysis – BAS to be particularly promising. Vacancies, defect complexes, free volume and the state of interphase boundaries exert a substantial influence on the electronic structure, adsorption properties, charge transfer and reactivity of catalytic materials. Positron annihilation spectroscopy does not replace surface-sensitive methods; however, when combined with X-ray photoelectron spectroscopy, electron paramagnetic resonance, diffraction methods and catalytic testing, it can provide complementary information about the type, concentration and spatial distribution of defects. The candidate's specialized expertise can therefore substantially expand the capabilities of the Laboratory of Design and Characterization of Catalytic Materials and the Surface Analysis research group in the investigation of functional materials and advanced oxidation processes.

5. **Participation in Scientific and Applied Research Contracts, Projects and Scientific Forums**

The submitted curriculum vitae does not include a separate list of the research projects and contracts in which Dr Popov has participated. Evidence of such activity can nevertheless be found in the publications. Some of the studies were carried out with the support of projects of the Joint Institute for Nuclear Research in Dubna and grants from the Plenipotentiary Representative of the Republic of Bulgaria to JINR. In individual publications, the candidate is explicitly credited with contributing to funding acquisition, in addition to his participation in the methodology and experimental work. His extensive work at JINR and his publications with international teams from Bulgaria, Azerbaijan, Vietnam, Poland, Romania, Slovakia, Türkiye and other countries demonstrate sustained international scientific cooperation.

The ADAPT-MRI project proposal, which has been submitted under the Danube Region programme and is currently undergoing evaluation, should also be added to the project activities undertaken at the Institute of Catalysis. The project focuses on the adaptive development of multifunctional magnetic nanomaterials for magnetic resonance imaging and magnetic hyperthermia in cancer treatment. In the proposal, Dr Popov is designated as the coordinator, and his expertise in positron annihilation spectroscopy is intended to be applied to the characterization of bulk defects and vacancy states in the nanomaterials, in combination with X-ray photoelectron spectroscopy and electron paramagnetic resonance. Although the outcome of the evaluation procedure is not yet known, his participation in the preparation and coordination of this

international project proposal demonstrates an intention to apply his specialized expertise to current research tasks at the Institute of Catalysis.

The curriculum vitae also does not contain a complete list of the candidate's participation in scientific forums. However, the submitted works include two publications in the Journal of Physics: Conference Series, associated respectively with the 4th International Workshop & Summer School on Plasma Physics and the 21st International Summer School on Vacuum, Electron and Ion Technologies. They demonstrate that results from his research have been presented and disseminated within international scientific forums. Owing to the absence of additional supporting documents, no quantitative assessment of his overall conference activity should be made.

6. Comments on the Submitted Materials

Some comments may be made regarding the submitted materials, mainly concerning their technical and editorial preparation and the insufficiently clear systematization of part of the information.

These shortcomings do not diminish the scientific value of the publications and do not alter my positive assessment of the candidate's professional qualifications and scientific competence. I recommend that Dr Popov devote greater attention to detail when preparing and presenting his scientific materials in the future.

CONCLUSION

The scientific research conducted by Assistant Professor Evgeni Petrov Popov, PhD, fully corresponds to the subject area of the announced competition for the academic position of Associate Professor. Dr Popov is an established specialist in the use of positron annihilation and theoretical calculations for the characterization of vacancies, vacancy clusters and other defects in solid-state materials. His methodological competence is complemented by the application of neutron diffraction, other spectroscopic methods and computer modelling.

The conducted studies address current problems in the physics and chemistry of condensed matter, materials science, corrosion processes and radiation physics. The obtained results have potential applications in nuclear fusion technologies, the space industry, and the development and characterization of materials for catalytic processes.

The candidate's publication record, the citation impact of his scientific results and his active participation in international research fully satisfy the requirements of the Development of the Academic Staff in the Republic of Bulgaria Act and the Regulations on the Terms and Procedure for Acquiring Academic Degrees and Holding Academic Positions at the Institute of Catalysis at BAS.

Based on my overall positive assessment, I confidently recommend that the members of the esteemed Scientific Jury propose to the Scientific Council of the Institute of Catalysis at BAS that Assistant Professor Evgeni Petrov Popov, PhD, be elected to the academic position of Associate

Professor in professional field 4.2. Chemical Sciences, scientific specialty “Solid State Chemistry”.

12 October 2026 Reviewer: ……
Sofia /Prof. Hristo Kolev, PhD/

Questions

1. What are the capabilities and limitations of positron annihilation spectroscopy in the investigation of defects in catalytic materials? How can the information obtained about vacancies and free volume be correlated with the results from surface-sensitive and spectroscopic methods such as XPS and EPR and with the measured catalytic activity?
2. Are you aware of studies in which radiation- or ion-modified materials have been used as catalysts or as supports for catalytically active phases? Would you be interested in developing such a research area at the Institute of Catalysis – BAS?
3. Is it possible, using the infrastructure and scientific cooperation available at JINR in Dubna, to prepare materials subjected to controlled irradiation or ion modification that could subsequently be characterized and tested as catalysts or catalyst supports at the Institute of Catalysis – BAS? In your opinion, what types of materials and radiation-induced defects would be the most suitable for such a collaborative study?