OPINION

by Prof. Dr. Ivalina Avramova Avramova

Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences

(Member of the Scientific Jury)

regarding the application of Chief Assistant Professor Dr. Evgeni Petrov Popov

"Design and Characterization of Catalytic Materials" Laboratory, "Surface Analysis" Research Group, Institute of Catalysis – BAS

for the academic position of "Associate Professor" in the professional field of 4.2. Chemical Sciences (Solid-State Chemistry) for the needs of the "Design and Characterization of Catalytic Materials" Laboratory at the Institute of Catalysis – BAS, the announcement for which was published in the State Gazette, Issue No. 58, p. 190, dated June 26, 2026.

Chief Assistant Professor Dr. Evgeni Petrov Popov is the only candidate in the competition for the academic position of Associate Professor in Professional Field 4.2 Chemical Sciences (Solid-State Chemistry) for the "Design and Characterization of Catalytic Materials" Laboratory at the Institute of Catalysis – BAS.

Dr. Popov has submitted all necessary documents for participation in the competition, which are required by the Law for the Development of the Academic Staff in the Republic of Bulgaria, Regulations for the application of the Law, as well as the Regulations on the terms and conditions for acquiring scientific degrees and for holding academic positions at IC-BAS.

Evgeni Popov studied physics at Sofia University "St. Kliment Ohridski," where he obtained his Master's degree in "Physics of the Atomic Nucleus and Elementary Particles" in 2006. From 2008 to 2013, he was a PhD student at the Institute for Nuclear Research and Nuclear Energy (INRNE) of the Bulgarian Academy of Sciences (BAS), receiving his doctorate in physics in 2014 with a thesis titled "Modeling the interaction of positrons in condensed matter used in ITER." Subsequently, he held positions as an assistant and later a chief assistant at the same institute until 2015. Between 2015 and 2025, he also worked part-time as a physicist at the Institute of Solid State Physics (ISSP) of the BAS, focusing on solid-state interactions and density functional theory. Since 2018, he has been working at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia, where he specializes in neutron diffraction and positron spectroscopy; he has held the position of Senior Researcher there since 2022. Since 2025, he has served as a chief assistant at the Institute of Catalysis of the BAS (in the Laboratory for Design and Characterization of Catalytic Materials), where he focuses on investigating structural defects in materials using XPS methods and applying positron spectroscopy techniques to support the Institute's research activities.

Dr. Popov is a co-author of 59 publications with 357 citations recorded in Scopus. A total of 19 scientific works were submitted for the competition: 18 published in international peer-reviewed journals with an impact factor (16 in Q1, 1 in Q2, and 1 in Q4) and one published in a journal without an impact factor. These works have received 84 citations (excluding self-citations by any of the authors). The candidate's Hirsch index (h-index), based on all published works included in the ISI database, is 10 (Scopus).

The habilitation report includes eight scientific publications (B1 through B8) that consolidate the candidate's research—utilizing scientific-engineering approaches and spectroscopic methods—into the

study and analysis of material properties intended for future service under dynamic radiation and corrosive operating conditions. In high-tech sectors such as Generation IV nuclear energy, fusion projects (like the international ITER reactor), and deep-space missions, components are subjected to constant bombardment by a wide spectrum of ionizing radiation; consequently, unprecedented demands are placed on the structural and shielding materials involved. Exposure to ionizing radiation leads to the formation of vacancies, clusters, and transmutation-induced changes within the materials, disrupting structural homogeneity, degrading mechanical properties, and reducing thermal conductivity. Accordingly, the candidate's research focuses on the study of ultra-high-temperature ceramics and nanostructured coatings.

The habilitation report addresses three areas. The first area is a summary of the analysis of radiation defects in materials for reactor and space applications under ion irradiation [publications B1, B4, B5, B6, B7].

Materials such as Ta/W and Fe-Cr irradiated with protons and neutrons, as well as W_2B produced via mechanical sintering of W, B_4C, TiC, and graphite, were examined under He+ irradiation and heavy-ion bombardment (Kr+, Cu+). B_4C phases in low-temperature zones were also studied; these formed as a result of the *in situ* synthesis of tungsten borides (W_2B, W_5B_2, WB_2) from W and B4C nanopowders subjected to intense irradiation by deuterium (D), tritium (T), helium (He), and neutrons, as well as secondary ionization caused by displaced atoms. Additionally, the commercial carbide Widia-N (WC-6Co) was investigated under irradiation with 132Xe ions (167 MeV). Research involving modeling has demonstrated that tantalum (Ta/W—tungsten clad with tantalum) and iron-chromium (Fe-Cr) alloys are suitable materials for components exposed to water corrosion and for the structural elements of the first wall. The W–6wt%B_4C–2wt%TiC–1wt%C composite has been tested under light-ion irradiation, confirming its suitability for the ITER diverter. Alloying with boron carbide (B_4C)—which combines high hardness and chemical stability with excellent performance—represents a promising alternative for applications involving light- and heavy-ion irradiation.

Despite its undeniable qualities, the commercial carbide Widia-N (WC-6Co) exhibits certain drawbacks under dynamic operating conditions that make it difficult to use in radiation or reactor environments; however, these same limitations do not pose a barrier to its application in other fields, such as space equipment.

The second area of research concerns the analysis of radiation defects induced by gamma irradiation in materials intended for reactor and space applications [publications B2 and B3].

ZrB_2 and TiN nanoparticles were investigated. The maximum gamma irradiation doses at which both materials—ZrB_2 and TiN nanoparticles—retain their functionality were determined.

A third significant area of work involves an engineering approach to adapting a cryogenic device for investigating structural and magnetic phase transitions via neutron diffraction [publication B8]. Samples of $HoFeO_3$ were studied, and magnetic phase transitions were observed in real time. An efficient cryostat was developed for conducting neutron diffraction measurements at low temperatures.

The author's summary lists 11 publications, which are thematically divided into two groups concerning materials subject to radiation and corrosion. The studies employ the positron annihilation method in conjunction with other techniques, such as neutron diffraction, X-ray diffraction, Raman spectroscopy, and

others. Radiation stability and thermal relaxation in nanocrystalline ZrB_2 are investigated in publications [Г1, Г2, Г8].

High-density polyethylene/silicon dioxide (HDPE/SiO_2) nanocomposite films were investigated as candidates for radiation shielding and insulation under high-dose gamma irradiation (100–500 kGy) in publication [G5]. The radiation resistance of tungsten composite materials alloyed with vanadium carbide (W-6wt%VC-1wt%C) was studied via irradiation with 2.5 MeV helium ions ($3He^+$), followed by analysis using X-ray diffraction (XRD), neutron diffraction (ND), Raman spectroscopy, atomic force microscopy (AFM), and positron annihilation. It was demonstrated that these materials exhibit improved relative density, hardness, and wear resistance, as well as high thermal stability, compared to pure tungsten. It was further shown that subsequent vacuum annealing for five hours at 1000 °C leads to effective relaxation and the recovery of the majority of bulk vacancy defects within the composite [G6]. The controlled generation of structural defects and the modification of properties in $BiVO_4$ thin films have been investigated. Experimental results and quantum-chemical calculations demonstrate that P^+-induced defects (V_O, V_{Bi}, and V_{Bi} + P_O) positively modulate the electronic structure of $BiVO_4$, enhancing charge transport and optimizing its optical properties. This leads to a significant improvement in photocatalytic performance and confirms the effectiveness of ion implantation as a precise tool for defect engineering in thin-film semiconductor materials [G9]. W-Ni alloys were studied under 2.5 MeV He^+ ion irradiation. Analysis reveals high radiation tolerance during ion irradiation, attributed to rapid self-recombination and defect absorption at phase boundaries. Defects localize within the minor Ni_4W phase while the bcc-W matrix remains stable, a phenomenon that necessitates precise control of the powder metallurgy process.

The influence of silicon (Si) and niobium (Nb) alloying additions, as well as the C/N ratio, on the structural-phase composition, neutron activation, and electrochemical corrosion behavior of multicomponent carbonitride coatings of the CNTi-(Zr, ZrNb, and ZrSi) type was investigated; these coatings were deposited via the cathodic arc method onto Ti_6Al_4V titanium alloy and 316L stainless steel substrates at a controlled C/N ratio of approximately 0.5 to achieve protective performance in aggressive environments.

Following intensive fast-neutron irradiation at a nominal power of 1450 kW, it was determined that none of the investigated coatings underwent long-term radioactive activation; furthermore, neutron flux bombardment did not affect surface morphology, crystal structure, or layer thickness, thereby demonstrating their pronounced radiation resistance and lack of structural deformation under these critical operating conditions. The TiSiCN, TiNbCN, TiZrCN, TiZrSiCN, and TiZrNbCN systems, deposited via cathodic arc evaporation, were also systematically investigated. It was demonstrated that the incorporation of Si in combination with Zr and Nb enables control over defect architecture and the optimization of properties for these advanced protective coatings intended for industrial and nuclear applications. The influence of pressure on the properties of ZrO_2 within Al_2O_3–YSZ composites was also studied. High hydrostatic pressure (600–700 MPa) was shown to ensure a homogeneous distribution of YSZ grains within the Al_2O_3 matrix, preventing agglomeration. This approach induces secondary recrystallization, with maximum density, hardness, and strength achieved at a YSZ content of 10–15%.

The submitted enquiry regarding the minimum national requirements and the candidate's additional qualifications has been completed correctly; the candidate exceeds the required minimums for the academic position of "Associate Professor" across the respective criteria.

I do not know Dr. Popov personally, but upon reviewing the documents he submitted for the competition, I am left with the impression that he is an accomplished researcher who skillfully resolves the scientific

problems at hand. Dr. Popov's work focuses on highly specialized areas—specifically positron spectroscopy and neutron diffraction—that are nonetheless valuable for investigating material properties relevant to future operational applications in nuclear reactors and space technology. Analyzing defect properties in a specific material using positron annihilation can be successfully combined with X-ray photoelectron spectroscopy (XPS) to characterize surface oxygen vacancies; this integrated approach provides a comprehensive picture of how oxygen vacancies evolve from the surface into the bulk, facilitating the study of catalytic and biological materials as well as those with medical applications.

I consider the candidate to be distinguished by a strong capacity for work and an analytical approach to resolving scientific and technical problems, as evidenced by his publication record and citation metrics. I am confident that this lays the foundation for a highly successful future career in research. I have no joint research or publications with the candidate, and the opinion expressed here is based entirely on the materials submitted for the competition.

In conclusion, I consider that the scientific output and activities of Chief Assistant Professor Evgeni Popov demonstrate scientific and applied-scientific results that constitute an original contribution to the field. This is clearly evidenced by the citation record of his publications and his participation in international research teams. All of this undoubtedly confirms that Dr. Popov is an internationally recognized scientist. Based on the foregoing, I give my unambiguous positive assessment of Chief Assistant Professor Evgeni Popov's candidacy and propose that the distinguished competition jury submit a recommendation to the Scientific Council of the Institute of Catalysis (BAS) for his election to the position of Associate Professor in the field of Chemical Sciences (Solid-State Chemistry) at the Institute of Catalysis (BAS), specifically for the "Design and Characterization of Catalytic Materials" laboratory.

October 5, 2026 Opinion prepared by:

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