

REVIEW

by competition for the academic position “Associate Professor” in the scientific specialty “Mineralogy and Crystallography – Experimental Mineralogy” by professional direction 4.4. “Earth Sciences” for the needs of the department “Structural Crystallography and Materials Science” at the Institute of Mineralogy and Crystallography “Acad. Iv. Kostov” (IMK) - BAS, announced in the “State Gazette”, no. 36/29.04.2025

Reviewer: Assoc. Prof. Stela Minkovska PhD, IC-BAS, member of the scientific jury under Order No. 36 RD-29/04/2025

1. Information about the Competition

Assistant Professor Dr. Hristina Ilieva Lazarova is the sole candidate in the competition for the academic position of Associate Professor in professional field 4.4. *Earth Sciences* (Mineralogy and Crystallography – Experimental Mineralogy), for the needs of the *Department of Structural Crystallography and Materials Science* at the Institute of Mineralogy and Crystallography “Acad. Ivan Kostov”, Bulgarian Academy of Sciences (BAS).

2. Brief Biographical Data and Research Interests of the Candidate

Dr. Lazarova graduated in 2008 from Sofia University “St. Kliment Ohridski” with a Master’s degree in Medical Chemistry. Following her graduation (2009–2017), she worked as a chemist at the Institute of Organic Chemistry with Centre of Phytochemistry (IOCCP–BAS), in the Laboratory of Organic Reactions on Microporous Materials (ORMM). From February 2017 to February 2021, she held the position of Assistant Professor in the same laboratory. Between February 1, 2021, and May 1 2022, she once again worked as a chemist, due to the expiration of the maximum four-year term permitted for holding the position of Assistant Professor. In 2020, by decision of the Scientific Council, she was admitted as an independent PhD student under the supervision of Prof. Margarita Popova. In 2021, she successfully defended her PhD thesis entitled: “*Development of Eco-Friendly Catalysts for the Production of Valuable Chemicals and Fuels through Biomass Utilization*”, receiving the educational and scientific degree “PhD”. In 2022, she was elected as an Assistant Professor at the Institute of Mineralogy and Crystallography “Acad. Ivan Kostov”, Bulgarian Academy of Sciences.

Dr. Lazarova’s research interests are in the fields of mineralogy, crystallography, and materials science. Her work focuses on the development of photocatalytic materials based on zeolite-like structures and Metal–Organic Frameworks (MOFs), as well as catalysts for obtaining valuable chemicals from biomass waste. Another important research direction includes the utilization of cement, fly ash, and zeolite-like structures for CO₂ capture and oxidation of volatile organic compounds (VOCs), as well as the synthesis of nanomaterials for applications as bioactive compounds and catalysts.

3. Evaluation of the Submitted Materials.

Assistant Professor Lazarova is co-author of 18 scientific publications, 17 of which are published in refereed and indexed journals with an impact factor (ISI IF). The materials submitted by Dr. Hristina Lazarova fully comply with the minimum national requirements for the academic position of *Associate Professor* in accordance with the Regulations on the

Conditions and Procedures for Occupying Academic Positions (RCPOAP) at the Bulgarian Academy of Sciences, the Regulations for the Implementation of the Act on the Development of the Academic Staff in the Republic of Bulgaria, as well as the internal rules of the Institute of Mineralogy and Crystallography “Acad. Iv. Kostov.”

The materials are grouped according to the official evaluation indicators:

- **Indicator A:** Doctoral degree – 50 points awarded (minimum required: 50).
- **Indicator B:** Habilitation work – scientific publications in journals indexed in internationally recognized databases (Web of Science and Scopus). The candidate submitted 6 publications: 2 in Q1, 3 in Q2, and 1 in Q4, for a total of 122 points (minimum required: 100).
- **Indicator C:** Scientific publications outside the habilitation work, indexed in Web of Science and Scopus. The candidate submitted 11 publications: 6 in Q1 and 5 in Q2, for a total of 250 points (minimum required: 220).
- **Indicator D:** Citations in refereed and indexed journals, monographs, collective volumes, and patents (Web of Science and Scopus). The candidate provided 27 citations, for a total of 135 points (minimum required: 60).

Indicators	Content / Indicator	Candidate's Points	Minimum required for “associate professor”
A	1. Doctoral thesis of earning a PhD degree	50	50
B	4. Habilitation work – scientific publications in journals with an ISI Impact Factor and/or SJR (Web of Science and Scopus)	122	100
		2-Q1	25 for published in Q1
		3-Q2	20 for published in Q2
		2-Q4	15 for published in Q3
			12 for published in Q4
			10 for published in edition with SJR without IF
G		250	220
	5. Published monograph, which not presented as a main habilitation thesis		30
	7. Scientific publication in publications, which are referenced and indexed in world-famous bases data with scientific information (Web of Science and Scopus), outside habilitation labor	6-Q1	25 for published in Q1
		5- Q2	20 for published in Q2
			15 for published in Q3
			12 for published in Q4

			10 for publication in an edition with SJR without IF
	8. Published head from book or collective monograph		15
D		135	60
	11. Citations in scientific publications, monographs, collective volumes and patents, referenced and indexed in world-renowned bases scientific data information (Web of Science and Scopus)*	27 citations × 5 points each	

The review demonstrates that Dr. Lazarova's scientific output meets, and in some indicators exceeds, the requirements for the academic position of *Associate Professor* in professional field 4.4. *Earth Sciences*, as specified in the Regulations for the Implementation of the Act on the Development of the Academic Staff in the Republic of Bulgaria (BAS) and in the internal regulations of the Institute of Mineralogy and Crystallography (IMC-BAS). In the submitted habilitation work, which summarizes the results of six publications (2 in Q1, 3 in Q2, and 1 in Q4), the candidate is the first author in two papers, the second author in one, and a subsequent author in the remaining publications. Five of these articles were published between 2023 and 2025, with only one dating back to 2017.

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

The scientific activity of Dr. Hristina Lazarova after receiving her PhD is a continuation of the knowledge and skills she has acquired. Her scientific interests are focused on the synthesis and development of photocatalytic materials based on zeolite-like and metal-organic frameworks Metal-Organic Frameworks (MOFs), micro-/mesoporous silicates and nanostructured oxides and their physicochemical characterization using temperature gravimetric analysis, temperature programmed reduction, infrared spectroscopy, UV-Vis spectroscopy, adsorption methods, study of the catalytic properties of modified nanocomposite materials, as well as oxidation of volatile organic compounds (VOCs). Dr. Lazarova has made a strong contribution to project activities at the Institute. She has project leader of two projects under the National Program *Young Scientists and Postdoctoral Fellows* (one under the *Young Scientists* module and one under the *Postdoctoral Fellows* module). She has also served as principal investigator of a project funded by the Bulgarian National Science Fund (BNSF) under the program for young scientists and postdoctoral fellows. Currently, she is leading a BNSF project under the COST program, entitled: "*Development and Characterization of Synthetic Porous Materials for Water Purification from Organic Molecules: Dyes and Pharmaceuticals.*" *Scientific Research Fund.*

Owing to her strong theoretical preparation and ability to work effectively in a team, Dr. Lazarova has also participated as a member of the research teams in five additional projects: the National Center for Mechatronics and Clean Technologies, and four BNSF-funded projects (one under the COST program and three under the Fundamental Research program). The results of her research have been presented at 21 scientific forums (10 international and 11 national), including 8 oral presentations and 13 poster contributions.

4. Main Scientific and Applied Contributions.

The scientific and applied research contributions of Dr. Lazarova address key contemporary societal challenges, including environmental protection, sustainable energy and energy efficiency, medicine, and green chemistry. The habilitation thesis has contributions of a theoretical and scientific-practical nature. Based on the presented materials, the following scientific and scientific-applied contributions can be summarized:

• *Development of photocatalytic materials based on zeolite-like and metal-organic frameworks (MOFs)*

1. **Highly active and stable photocatalysts were synthesized**, based on zeolite-like microporous Engelhard titanosilicates (ETS-4 and ETS-10), in which Ti centers were substituted with Zr. The samples were characterized by advanced physicochemical methods, including X-ray diffraction, scanning electron microscopy, ultraviolet and photoelectron spectroscopy, infrared spectroscopy, and BET/SSA analyses. Comprehensive information was obtained regarding the bulk and surface properties of the materials. More than 90% degradation of persistent dyes such as Crystal Violet and Methylene Blue was achieved within 60 minutes under UV irradiation. Kinetic studies revealed that the process follows a nonlinear pseudo-second-order model [B4.1 and B4.3].
2. **A novel zinc-based metal-organic coordination polymer (MOF-S1) was synthesized**, featuring an ultramicroporous structure and a specific surface area of 711 m²/g. It exhibited 93% degradation of Methyl Orange and 74% degradation of Rhodamine B under UV irradiation, making it a promising material for wastewater treatment [B4.4].
3. **An OSDA-free SBA-15 mordenite was synthesized**, modified with HF and NH₄ F, resulting in enhanced porosity and improved accessibility of acid sites. The samples were characterized by X-ray diffraction, N₂ adsorption, SEM, HR-TEM, and solid-state NMR. In the m-xylene isomerization reaction, the modified materials demonstrated significantly higher catalytic activity compared to the unmodified analogue [B4.6].

• *Development of catalysts for sustainable biomass waste conversion*

1. **Nickel-containing zeolite catalysts (Beta, Faujasite, Mordenite, ZSM-5) were synthesized** and investigated for hydrogen production from polyolefin plastics under inert conditions. A significant reduction in degradation temperature to ~250 °C and a high hydrogen yield (up to 50% in the gas phase) were achieved. The high catalytic activity ensured the selective formation of aromatic compounds, branched alkanes, and alkylbenzenes, with nickel identified as the key factor for efficiency. [Habilitation thesis: B4.5]
2. **A method was developed for the synthesis of the bio-renewable alcohol pentane-1,2,5-triol** via hydrogenation of an intermediate derived from furfuryl alcohol. The process proceeds under atmospheric pressure, without solvents, and with 100% selectivity. Mesoporous silica catalysts containing Ni and Pt enabled complete conversion of the feedstock to the target product under mild reaction conditions, while preserving the stability of the furan ring. [G7.4].
3. **A method was developed for the synthesis of the biofuel additive 5-(t-butoxymethyl)furfural (t-BMF)** from 5-hydroxymethylfurfural (HMF) and t-butanol.

Among the 27 catalysts tested, Preyssler heteropolyacid and CLOI_CSP showed the highest efficiency, providing >95% selectivity and high reaction rates. CLOI_CSP was identified as the most effective catalyst, combining high selectivity (>95%), stability, and suitability for sustainable continuous production. [G7.6]

• **Utilization of cement dust, fly ash, and zeolite-like materials for CO₂ capture and VOC oxidation.** [Γ7.5, Γ7.7, Γ7.8, Γ7.9, Γ7.10, Γ7.11 u Γ7.12]

1. **Zeolite-like materials from fly ash:** Na-X materials with high surface area and mixed porosity were synthesized; Cu modification (5%) significantly enhanced catalytic activity in VOC oxidation due to Cu dispersion and Fe presence.
2. **CO₂ adsorption and VOC oxidation:** Fly ash-derived materials were developed that simultaneously adsorb CO₂ and catalyze VOC oxidation. High efficiency was achieved through Fe³⁺ /Fe²⁺ redox couples and 6% Co modification, depending on zeolitization and iron valence state.
3. **Cu-Fe/Al₂ O₃ catalysts and nanocomposites:** The influence of alumina precursors on Cu-Fe/Al₂ O₃ activity in toluene oxidation was studied. Additionally, zeolite-like nanocomposites from fly ash containing Fe oxides and Cu, Co, Mn impurities were synthesized, showing high stability and multifunctionality as catalysts, CO₂ adsorbents, anticorrosion coatings, and substitutes for critical raw materials.
4. **Stability and modification effects:** Ca-containing fly ash materials improved CO₂ sorption and stability, while plasma treatment enhanced catalytic activity in toluene oxidation, offering an alternative to Pt catalysts. Cement waste also demonstrated potential for CO₂ capture via mineral carbonation, supporting industrial waste valorization for climate resilience.
5. **Novel catalytic systems and nanomaterials:** Cu-based catalysts enabled selective oxidation of 5-chloromethylfurfural (CMF) to 2,5-diformylfuran (DFF), a key bio-based monomer; Ag-modified silicates were developed for antimicrobial applications; and SnO₂ /zeolite catalysts exhibited high activity in levulinic acid esterification for green chemistry and bioapplications.

Dr. Lazarova's habilitation thesis presents scientific, scientific-applied, and applied results that constitute original contributions to the field of materials science. Novel functional materials with potential applications have been developed and comprehensively characterized using advanced physicochemical methods, including X-ray diffraction (XRD), scanning electron microscopy (SEM), UV-Vis and photoelectron spectroscopy, infrared (IR) spectroscopy, and BET/SSA analyses. The catalytic activity of the materials was evaluated in processes such as complete oxidation of volatile organic compounds (VOCs), isomerization of aromatic compounds, and CO₂ capture.

2. Reflection of the Candidate's Scientific Publications in Bulgarian and International Literature.

A total of 27 citations of 5 articles (excluding self-citations) have been recorded in peer-reviewed journals indexed in leading international databases (Web of Science and Scopus), thereby fulfilling the requirements under Indicator Group D. The h-index (according to Scopus) is 12.

3. Critical Remarks and Recommendations.

I have no critical remarks concerning the candidate. The application documents are prepared in accordance with the requirements and provide comprehensive information on the results achieved as well as the candidate's scientific and applied contributions. The only omission I identified is the absence of a clearly presented plan for the candidate's future research work.

4. Personal Impression.

I have known Dr. Hristina Lazarova since the defense of her PhD thesis, where I served as a member of the scientific jury. At that time, she made a very positive impression with her well-structured work and the sound approach to interpreting results.

Conclusion

The habilitation thesis and publications presented by **Dr. Hristina Ilieva Lazarova** are fully aligned with the topic of the competition and constitute original scientific and applied research with significant contributions in the fields of materials science and heterogeneous catalysis. The obtained results are of both fundamental and, to a large extent, applied scientific character.

The documents and materials submitted by **Assist. Prof. Dr. Hristina Lazarova** fully comply with all requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Regulations on the Conditions and Procedures for Acquiring Academic Degrees and Occupying Academic Positions of the Bulgarian Academy of Sciences, as well as the corresponding regulations of the Institute of Mineralogy and Crystallography, related to the procedure for occupying the academic position of Associate Professor.

On the basis of the submitted documents, I hereby propose to the esteemed Scientific Jury and to the Scientific Council of the Institute of Mineralogy and Crystallography – BAS to confer the academic title of Associate Professor upon Dr. Hristina Ilieva Lazarova in the professional field **4.4. Earth Sciences** (Mineralogy and Crystallography – Experimental Mineralogy), for the needs of the Laboratory of Structural Crystallography and Materials Science at the Institute of Mineralogy and Crystallography – BAS.

Sofia

3.09.2025

Reviewer:

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съгласно чл. 2 от
ЗЗЛД**

(Assoc. Prof. S. Minkovska) PhD