

OPINION

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Regarding: Competition for taking up the academic position "PROFESSOR",

professional field 4.2 Chemical Sciences, Solid State Chemistry,

for the needs of the laboratory "Design and Characterization of Catalytic Materials",

Institute of Catalysis - Bulgarian Academy of Sciences

(IC-BAS), promulgated in 82/07.10.2025

Information about the procedure

I present this opinion in my capacity as a member of the scientific jury, in accordance with the Order of the Director of the IC-BAS (RD-09-91 from 09.12.2025) and the decision of the first meeting of the scientific jury from 18.12.2025. The only candidate in the competition is Assoc. Prof. Hristo Gospodinov Kolev, PhD.

Brief biographical and professional data of the candidate

Assoc. Prof. Hristo Kolev was born in 1974. In 1998 he received Master's degree in Engineering Physics, Sofia University "St. Kliment Ohridski", Sofia, Bulgaria. In 2009 he successfully defended his PhD program in Physics at the Westfälische Wilhelms University of Münster, Münster, Germany.

Over the years, Dr. Kolev has held various positions in the private sector. His scientific career began in 1999 as a physicist at IGIC-BAS. Then he specialized at the Westfälische Wilhelms University of Münster, Münster, Germany. In 2004 he was appointed as a physicist at the IC-BAS, in 2011 he held the academic position of Chief Assistant Professor, and since 2014 he has been an Associate Professor at the IC-BAS.

Scientific research activity

I. Habilitation report

After the correction of the scientific data, Assoc. Prof. Dr. Hristo Kolev participated in the competition for "professor" with 77 scientific publications, specialized scientific journals which are referenced and indexed in the world-famous databases of scientific information Web of Science and Scopus, 10 of which are in the habilitation report (group

B). Proof of the value of Assoc. Prof. Kolev's scientific production is the large number of citations of his scientific works in which he participated. The attached report presents a total of 1040 citations, all referenced and indexed in the world-famous databases of scientific information Web of Science and Scopus. The candidate's Hirsch index is 18. For participation in the competition, in group B of the minimum requirements of the IC-BAS for the acquisition of scientific degrees and holding academic positions, as mentioned above, the candidate has submitted 10 scientific publications, which are equivalent to a habilitation thesis.

The publications submitted by the candidate are dedicated to establishing the relationship between the electronic structure of the surface and catalytic activity in systems with different amounts of transition metal oxides: Co, Mn, Ni, Fe, Ce, Sm, Zn and their combined forms. X-ray photoelectron spectroscopy (XPS) was used as the main method for analyzing the materials in combination with other known methods for analyzing materials.

1. Co-containing oxide catalytic systems

Active and thermally stable Pd-Co/ γ -Al₂O₃ catalysts for the complete oxidation of methane have been developed by controlling the Co content. The aim of the presented works is to clarify the role of cobalt oxide in stabilizing PdO and participating in the delivery of surface oxygen species. It was found that monolithic Fe-Cr-Al samples with optimized composition (0.05% Pd/0.3% Co) operate at about 50 °C higher temperatures than their counterparts on powdered Al₂O₃ due to mass transfer limitations. The results clearly emphasize that cobalt oxide stabilizes palladium in the oxidized state and facilitates the redox cycle determining the activity in methane oxidation.

Activated carbons have been studied as support for nanodispersed cobalt oxide phases used in the catalytic decomposition of methanol. A clear relationship has been established between the porous structure of the carbon supports, the oxidation state of the cobalt species and the catalytic efficiency. The mixed Co²⁺/Co³⁺ phases and their degree of accessibility play a key role in determining the activity and selectivity in methanol conversion.

Catalysts based on Co-Mn oxide phases deposited on clinoptilolite, intended for the oxidation of volatile organic compounds, have been studied. The main emphasis is placed on the role of the valence states of cobalt and manganese, the oxygen mobility

and the interaction between the active phase and the zeolite support. It has been established that the Co–Mn/clinoptilolite catalysts owe their efficiency to the mixed $\text{Co}^{2+}/\text{Co}^{3+}$ and $\text{Mn}^{3+}/\text{Mn}^{4+}$ surface states, the high oxygen mobility and the structural stability of the active phase.

2. Fe-containing catalytic oxide systems

Mesoporous Ce–Fe–Ni mixed oxides with controlled metal content were synthesized, followed by stepwise reduction and carbonization with methanol to obtain metal–carbon composites, including Ni–Fe alloys and Fe–carbide nanophases encapsulated in carbon nanotubes. It was found that Fe-containing oxide phases, and a high degree of defectivity at the formed metal–carbon interfaces, create favorable conditions for electron transfer, which explains the increased electrocatalytic activity in oxygen evolution reaction (OER).

Activated carbon supports modified by hydrazine treatments and doped with $\text{Ni}_x\text{Fe}_{3-x}\text{O}_4$ spinels were studied, which were subsequently subjected to methanol decomposition to induce coking. The main objective of the presented work is to evaluate whether carbon accumulation – usually undesirable in thermocatalysis – can be used as a mechanism to improve electrochemical properties and reuse “spent” catalysts. The results show that coking leads to the formation of new electrically conductive carbon structures and additionally activates Fe–Ni spinel phases, which significantly lowers the transfer resistance and reduces the OER overpotential.

$\text{SmFeO}_3/\text{CuO}$ composites with different phase ratios were synthesized for the activation of peroxomonosulfate and degradation of the antibiotic sulfathiazole. The heterostructural interfaces between SmFeO_3 and CuO aim to improve charge separation and facilitate the formation of reactive oxygen species. It was found that the $\text{SmFeO}_3/\text{CuO}$ heterostructure creates stable surface active centers, with the $\text{Fe}^{3+}/\text{Cu}^{2+}$ synergy facilitating the formation of OH , SO_4^- and $^1\text{O}_2$ – the main reactive oxygen species responsible for the degradation of the antibiotic.

3. Ni-containing catalytic oxide systems

Monometallic Ni/Ce–Zr and bimetallic Ni–Sn/Ce–Zr catalysts with Sn content (2.5–10 wt.%) were developed, subjected to reduction and studied in ethylene glycol APR. The main goal is to reveal the synergistic role of Sn and initial pH (neutral vs. strongly alkaline) on the formation of Ni–Sn intermetallic compounds, the stability of Ni^0 nanophases and

the catalytic pathways for the formation of H₂ and organic products. The results show that Sn stabilizes Ni⁰, reduces the tendency for excessive C–C hydrogenolysis and suppresses methanation, leading to higher selectivity to hydrogen.

4. Oxide catalytic systems containing rare earth elements

Pure and rare earth modified ZnO powders containing La₂O₃ and Eu₂O₃ (2 mol %) were synthesized for the tribocatalytic decomposition of doxycycline under dark conditions. The results show the presence of Zn²⁺ signals, as well as stable valence states La³⁺ and Eu³⁺, with a higher surface concentration of La in ZnO/La compared to the partially shielded Eu in ZnO/Eu. An increase in the components associated with defective oxygen in both modified materials was found. ZnO/La demonstrated the fastest tribodegradation, explained by a more efficient separation of triboinduced charges and stabilization of active oxygen centers.

II. Scientific contributions in the materials presented as non-habilitation publications

The author's reference for the candidate covers 10 publications, and the reference for minimum requirements reflects many more. The publications include studies of oxide and hybrid materials for energy storage and conversion, and oxide materials containing rare earth elements with potential applications in luminescence and medicine.

The first direction combines research that is dedicated to the preparation of oxide materials for solid oxide fuel cells and electrode materials for lithium-ion batteries. The main goal of the presented works is to trace the relationship between the crystal and electronic structure, oxygen defects and ion-electron transport.

The second direction covers studies of lanthanide-containing oxide and MOF-based materials with luminescent properties. The main contribution is in the detailed surface characterization and the correlation between valence states, coordination environment and emission properties.

The third direction unites the development of magnetic nanoparticles and functional nanomaterials with potential for application in nanomedicine - magnetic hyperthermia, MRI contrast agents and electrochemical biosensors. The surface chemistry and active centers that govern the magnetic, catalytic and electrochemical response have been determined.

All publications demonstrate the candidate's contribution, as well as the application of X-ray photoelectron spectroscopy in the study of the above-mentioned materials. From the comparison between the minimum national requirements and the results achieved by Assoc. Prof. Dr. Hristo Kolev, it is evident that the presented scientific production meets and significantly exceeds the requirements for holding the academic position of "professor". The total number of points of Assoc. Prof. Kolev is 4226 out of the required minimum number of 600.

CONCLUSION

The review and analysis of the documents and materials submitted by Dr. Hristo Kolev in the announced competition shows that they meet and significantly exceed all legal requirements for acquiring the academic position of "professor". Based on the above, I give my positive assessment and propose to the Scientific Jury to award Assoc. Prof. Hristo Kolev the academic position of "professor" in the professional field 4.2 Chemical Sciences (Solid State Chemistry), for the needs of the laboratory "Design and Characterization of Catalytic Materials" at the IC-BAS.

05.02.2026

Assoc. prof. Lyubomir Aleksandrov