

OPINION

on competition for a professor for the needs of
Institute of optical materials and technology "Acad. Jordan Malinowski"
in scientific direction 4.2. Chemical sciences, specialty Physical Chemistry
announced in SG No. 79 of 04.10.2022

with candidate: Assoc. Prof. Dr. Daniela Bogdanova Karashanova
by Prof. DSc Vessela Tsakova-Stancheva, member of the Scientific Jury

**1. General characteristics of scientific research and applied science
activity of the candidate**

Daniela Karashanova began her professional career in 1997 as a full-time doctoral student in the Central Laboratory of Photoprocesses "Acad. Jordan Malinowski" at Bulgarian Academy of Sciences (BAS), today the Institute of Optical Materials and Technologies "Acad. Jordan Malinowski" (IOMT), BAS. Subsequently, she worked as a physicist and chief assistant at the same institute, and since 2010 she was elected associate professor and head of the Laboratory for Electron Microscopy at IOMT, BAS, a position she holds until now.

In the period after her appointment as associate professor, from 2010 to now, she is the author and co-author of a total of 111 publications, the majority of which were published in renowned international journals. This scientific work, significant in volume and quality, is due to her essential role in the investigation of the structure, morphology and phase composition of various types of materials using transmission electron microscopy (TEM) and high-resolution TEM (HRTEM).

According to the Report form of fulfillment of minimum requirements of IOMT filled out by the candidate, in the current competition Assoc. Prof. Karashanova participates with 18 publications and one patent. Six publications are accepted as equivalent to a habilitation work (indicator "B") with a total number of 140 points at a required minimum of 140, and another twelve publications (outside those included in the habilitation work) and one patent, according to indicator "D", collect a total 305 points at a minimum requirement of 260 points. (280 points appear in the candidate's Report form under indicator "D", but the points for one of the articles, B7, are not added to the total.) The papers with which the candidate participates in the competition are published in high-ranking journals - 13 in Q1-ranked journals, 4 in Q2-ranked journals and one in a Q3-ranked journal. All articles (except one, B7) and the patent are published in the period 2019-2022.

The total number of points for the other indicators: citations (indicator from group "D") - 168 points (with a required minimum of 120 points) and participation in projects (indicator from group "E") - 260 points (with a required minimum of 150 points) also exceed the corresponding minimum requirements. In general, the data presented in the *Reference on the implementation of the minimum requirements* show that the parameters of the candidate in the competition exceed the minimum requirements of the Bulgarian Law for academic development and the Regulations of IOMT, BAS.

Apart from the formal evaluation of the numerical parameters for participation in the competition, it should be noted that the materials provided testify to an extremely intensive research activity of the candidate, which, after her election as an associate professor, includes participation in a total of 11 research projects. She was also the head of two projects for co-financing of the VI Crystallographic

Symposium and the International School of Fundamental and Electronic Crystallography. These two projects give evidence for the efforts of Prof. Karashanova to raise the level of education of young researchers and spread knowledge in the field of crystallography and methods for structural, morphological and phase studies of materials. A further argument in this respect is the course *Electron microscopy and electron diffraction in the morphological and phase analysis of materials* (including 30 hours of lectures and 15 hours of exercises) at the BAS Training Center led by Assoc. Prof. Karashanova. From 2008 until now, she is the chairman of the Organizing committee of the annual spring seminar *Interdisciplinary Chemistry* organized by IOMT for doctoral students and young scientists from BAS.

Furthermore, the candidate's commitment with activities related to the administration and management of science in the country should be underlined. She was (until 2020) the representative of the Ministry of Education and Science in the Program Committee of FP *Horizon 2020* in the field of *Nanotechnologies, advanced materials, biotechnology, advanced production and advanced processing*. Dr. Karashanova is member and actual vice-chairman of the Permanent Scientific Expert Committee on Chemical Sciences at *Bulgarian Science Fund*.

2. Basic scientific and applied contributions.

The research presented for the competition was carried out in broad collaborations with a great number of co-authors from Bulgarian and foreign academic institutions. The candidate's *Reference for the scientific contributions* provides a detailed description of the complex studies of various materials, synthesized in the partner laboratories, with a clear identification of the role of TEM or HRTEM studies that were carried out to clarify the structure and phase composition of the investigated materials. In many cases, the studies refer to situations where the application of standard methods, e.g. powder X-ray diffraction, is not possible due to the small size of the particles, the use of thin layers or the scarce amounts of the active phases responsible for the specific (catalytic) action of the materials.

The scientific research presented in the current competition is grouped around three subjects:

- TEM and electron diffraction for the study of microstructure and phase composition of innovative catalytic materials.
- TEM of graphene and thin film materials
- TEM of metal and composite nanoparticles obtained by laser ablation in different media

In all three groups of publications, the main contributions of the candidate are related to her high expertise in the field of the experimental and evaluation techniques related to TEM and HRTEM and the resulting possibilities for morphological and structural characterization of complex nanoscale systems.

In the publications of the first group, the contributions relate both to the identification and characterization of the catalytically active metal nanoparticles and to the study of the structural and morphological characteristics of the support, whose role in the catalytic process is no less essential. The more important contributions are as follows:

1. A study (paper A5) of a catalyst for formaldehyde oxidation based on gold nanoparticles deposited on a support of mixed oxides of cobalt, ceria and aluminum revealed the presence of gold nanoparticles with sizes of the order of 3-4 nm. It has been demonstrated that when using a binary mixture of cerium and cobalt oxides, the gold particles are deposited predominantly on

the cerium oxide phase, and when using a γ - Al_2O_3 substrate, the close contact of Au nanoparticles with the aluminum oxide phases plays an essential role.

2. Within the framework of a comparative study (paper A1) of two copper catalysts supported by mixed cerium and Y-doped aluminum oxides (synthesized by mechanochemical mixing or by impregnation) a difference was found in the phase composition and structure of the supports depending on the synthetic method. This finding is in the origin of the different behavior of the two materials for the investigated catalytic reaction. The formation of a complex multicomponent phase of $\text{Al}_{10}\text{Ce}_{0.02}\text{O}_{24}\text{Y}_{5.98}$ found for the impregnation method hinders the favorable interaction of CuO and CeO_2 , as a result of which this catalyst shows a lower activity in the studied reaction of obtaining hydrogen by the interaction of carbon monoxide with water vapor.

3. In the study (paper A6) of mixed manganese-cerium oxides (synthesized on mesoporous amorphous silicon) the phase composition of the manganese-oxide phase was established with the help of HRTEM and corresponding Fourier transformation of the generated images. Thus, evidence was obtained for the presence of Mn^{4+} , which plays an essential role in the activity of the catalyst for the propane oxidation reaction.

Some of the main contributions from the other two thematic groups, which relate to thin-film carbon materials and metal nanoparticles obtained by laser ablation, can be summarized as follows:

4. By means of electron diffraction unambiguous evidence is provided for the deposition of bi-layer graphene structures on a copper substrate obtained by chemical vapor deposition in a turbulent flow (paper B1). The angles of rotation of the layers relative to each other were also determined and found to be in agreement with data obtained by an independent research method.

5. In the study of metal and composite nanoparticles (papers B7, B8, B9, B11, B12, and patent C1), obtained by pulse laser ablation, the sizes, morphology and phase composition of the metal particles were determined depending on the synthetic conditions. This provided the opportunity to optimize the specific approaches to obtain metal particles with pre-designed characteristics in view to their applications as materials suitable for Surface Plasmon Resonance (SPR), Surface Enhanced Raman Scattering (SERS) or for ophthalmology.

4. Citations of the candidate's scientific publications in Bulgarian and foreign literature.

After her election as an associate professor, the works of Dr. Karashanova have been significantly cited in the international scientific literature - a total of 518 citations are found according to the provided list. The applicant's Hirsch index according to Scopus is 11. For the competition, a list of 84 citations is presented, almost half of which are from papers published in the period 2019-2022.

5. Critical notes and recommendations - none.

6. Personal impressions of the reviewer about the candidate.

I have known Daniela Karashanova since she entered IOMT as a doctoral student and I have witnessed her development as a specialist, Assistant and Associate Professor at IOMT. I have excellent impressions of her work, her attentive attitude to various research problems, her responsiveness and ability to work collaboratively with multiple research groups. I also highly appreciate her efforts related to increasing the qualifications of specialists, young scientists and doctoral students in the field of electron microscopy and crystallography.

CONCLUSION

Based on the materials submitted for the competition, the quality of the scientific publications, the active research, educational and scientific-administrative activity and, last but not least, the high scientific competence of Associate Professor Daniela Karashanova in the field of application of transmission electron microscopy and electron diffraction for structural and phase analysis, I consider that she fully meets the requirements of the Bulgarian Law for academic development and its Regulations for occupying the academic position of "Professor".

With deep conviction and pleasure, I support the election of Assoc. Dr. Daniela Karashanova as a professor at the Institute of Optical Materials and Technologies "Acad. Jordan Malinowski", BAS.

26.01.2023

Member of the Scientific Jury:

/Prof. DSc Vessela Tsakova/