REVIEW

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concerning

competition for an Associate Professor position at the Institute of Optical Sciences and Technologies, BAS in professional field 4.2 Chemical Sciences, scientific specialty "Physical Chemistry"

The competition for associate professor was announced in the State Gazette no. 35/10.05.2022 for the needs of the Institute of Optical Materials and Technologies (IOMT) - BAS. Only one candidate, Dr. Bilyana Chavdarova Georgieva, applied for the opened position. She submitted a complete set of documents in accordance with the requirements of the Regulations for the Implementation of the Law on the Development of the Academic Staff in the Republic of Bulgaria. The documents are complete and provide the necessary information for evaluating the research activity of ch. assistant Dr. Bilyana Georgieva.

1. Biographical data

Bilyana Georgieva accomplished the master's program in chemistry at the "Inorganic Chemistry" department of the Faculty of Chemistry of the "St. Kliment Ohridski" University in 1997, with a major in "Especially pure substances and materials based on them". She successfully defended a dissertation for obtaining the educational and scientific degree "doctor" on the topic "Vacuum deposited Sn-O-Te layers as sensors for moisture and reducing gases" at the Institute of Optical Materials and Technologies "Acad. J. Malinovski" - BAS under the supervision of Associate Professor Dr. Veselina Platikanova in 2012.

Bilyana Georgieva joined the Central Laboratory of Photoprocesses - BAS in 2000 as a chemist. Between 2007 and 2013, she was an assistant (research associate) at the Institute of Optical Materials and Technologies - BAS. From 2013 to the present, she is chief assistant in the Electron Microscopy Laboratory of the same institute. Throughout this period, she engaged in scientific activity in the field of obtaining vacuum-evaporated thin metal oxide films, working with vacuum installations, measuring electrical resistance of thin layers, researching gas sensor properties of thin metal oxide films and their relationship with the phase composition and structure. In recent years, she also gained experience in transmission electron microscopy.

2. Compliance with minimum requirements

The candidate ch. assistant Bilyana Georgieva participates in the competition with 19 publications (18 of them were published after receiving the educational and scientific degree "Doctor", and one - before, but it is outside the subject of the doctoral dissertation), of which 5 are equated to a habilitation thesis (group of indicators "B", indicator "4") and 14 in group of indicators "D", indicator "7". Of the first 5 publications, 3 are ranked Q1 and 2 are ranked Q2. Of the second 14 publications, one was ranked Q1, 6 ranked Q2, one ranked Q3, 3 ranked Q4, and 3 had no impact factor. Thus,

according to group "B" indicators, the candidate collects 115 points out of 100 required, and according to group "D" - 226 out of 220 required by the Law on the Development of the Academic Staff in the Republic of Bulgaria (ZRASRB) and the Rules for its Application in IOMT-BAS.

For participation in the contest, 46 citations of two publications with the participation of the candidate were submitted, which earned her 92 points under the "D" indicators out of the required 60.

In this way ch. assistant Dr. Bilyana Georgieva meets the minimum requirements for holding the academic position "associate professor" defined in the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations for the Terms and Conditions for Acquiring Scientific Degrees and Holding Academic Positions at IOMT-BAS.

3. Participation in scientific forums and contracts

A list of 73 participations at scientific forums and conferences is provided. Of these, 41 posters and 21 reports were presented at a forums in Bulgaria, in most cases with international participation, and 5 posters and 6 reports were presented abroad.

Chief Assistant Dr. Bilyana Georgieva has some administrative experience. She was the coordinator for IOMT of two scientific research contracts with the Scientific Research Fund in 2008 and 2017. She was also the administrator for IOMT of the Center of Excellence "National Center for Mechatronics and Clean Technologies" funded by OP NOIR. In 2014, she led a project under the Operational Program "Development of Human Resources", for the Support of articles in refereed publications and publications with an impact factor.

The presented documentation provides information on Bilyana Georgieva's participation in five other research contracts with the Scientific Research Fund in the period 2016-2021. She is also a member of the IOMT team as a partner in the INFRAMAT project for national scientific infrastructure.

4. Scientific and research activities

The scientific research activity of Bilyana Georgieva is concentrated exclusively on the research of materials with a transmission electron microscope and the related electron diffraction. The research has an applied nature and is focused on nanostructured materials with potential applications in catalysis, sensor technology and various optical and electronic devices. The contribution of electron microscopy with micro-diffraction consists in providing data to establish a relationship between the method of preparation, the structure and the properties important for the applications.

4.1. Description and contributions in articles presented as the equivalent of a thesis

In the articles presented as a habilitation thesis, layers of metal oxides were investigated, which can be divided into two groups. The first are layers of ZnO, ZnO doped with Au, TiO_2, SnO_2 and MoO_3, which are used as an active layer in sensors for various reducing gases and vapors of organic solvents such as acetone, ammonia and ethanol, and the second are oxides of transition metals with potential application as low-cost catalysts in methanol degradation and hydrogen production.

The main contributions of the works presented as a habilitation thesis can be summarized as follows:

- It was found that in silver-doped zinc oxide layers obtained by the method of pulsed laser deposition and subsequent annealing, silver is separated into crystalline nanoparticles. The morphology of the particles, their location in the oxide matrix, as well as the morphology of the matrix itself, depending on some parameters of the preparation conditions, were determined.
- The morphology, including nanoparticle size and crystal structure of the formed phases in nanostructured oxide films of ZnO, TiO_2, SnO_2 and MoO_3 obtained for the first time by pulsed laser deposition in air are characterized.
- A similar characterization was made for transition metal oxide nanoparticles deposited on an activated carbon support. The morphology, size and phase composition of the particles were determined, and it was shown that they can also be controlled by treating the carbon support. The obtained result contributes to clarifying the mechanism of methanol decomposition and hydrogen production.

4.2. Description and contributions in articles presented beyond the equivalent of a thesis

The larger number of articles presented outside of the habilitation thesis also implies a more extensive topic, which the candidate has divided into three areas. The first area concerns the fabrication and testing of resistive sensor elements for moisture detection based on vacuum-deposited polyimide and SnO_2 thin films. This area is not focused on electron microscopic observations and diffraction, but involves the preparation of 50-280 nm thick polyimide layers and about 60 nm thick SnO_2-TeO_2 layers, subsequent testing for humidity detection and elucidation of the resistance change mechanisms of the layers depending on the humidity.

The second area is research by transmission electron microscopy and electron diffraction of thin films with controllable porosity based on oxides of Nb, Ta and V. It includes the largest number of articles – 10. The oxide films were obtained by the sol-gel method followed by spreading on a substrate by spin coating. Additional porosity is provided by polymeric materials, that form a sacrificial template. The variety of possibilities for combining oxides, polymers and preparation procedures is quite large, which is why electron microscopy plays an important role for initial evaluation of the obtained result. The layers obtained in this way are amorphous and the microscopic evaluation is limited to the morphology, size and amount of pores. A layer of hydrothermally obtained MFI zeolite and a one-dimensional photonic crystal consisting of alternating mesoporous V_2O_5 and PMMA layers were also characterized.

The third area is a study by transmission electron microscopy and electron diffraction of silver nanoparticles obtained by "green" synthesis using waste from the essential oil industry. With electron microscopy, the possibility of obtaining silver nanoparticles using waste from the flowers of Rosa Damascena, yarrow and lavender has been proven for the first time. The particles were characterized by morphology and size, and comparisons were made between the results of the preparation procedures with the different plants.

The main contributions of the works submitted beyond the equivalent of a thesis can be summarized as follows:

- The type of adsorption of water molecules on the surface of thin polyimide and SnO_2 layers was determined. It has been proven that physical adsorption prevails in organic layers, which leads to a quick response to changes in humidity and independence from the thickness of the layer.
- By impedance spectroscopy, the presence of both electronic and ionic conductivity in layers of SnO_2 obtained by co-vacuum deposition has been demonstrated for the first time. Unlike organic layers, this implies both chemical and physical adsorption of water molecules on the surface of the layer.
- The morphology and structure of dense and mesoporous Nb-, Ta- and V-oxide thin films obtained by sol-gel and spin-coating were characterized by the methods of transmission electron microscopy and electron diffraction. The essential role of organic additives for the formation of a mesoporous layer has been proven. The amorphous structure of the thin oxide layers has been proven.
- It has been proven that the hydrothermally synthesized zeolite used as a layer in an optical sensor for organic vapors has an MFI type structure. The morphology of the obtained zeolite particles was also observed.
- Through transmission electron microscopy and electron diffraction, it has been demonstrated for the first time that a procedure involving aqueous extracts of the waste products of the flowers of Rosa Damascena, Achillea millefolium and Lavandula angustifolia used in the essential oil industry can produce silver nanoparticles. The morphology and size of silver nanoparticles produced by this new type of "green" synthesis are also shown.

5. Impact of the candidate's scientific output in the literature

The candidate submitted 46 citations from only two articles. According to Scopus, to date, the number of citations of Dr. Bilyana Georgieva is 149, and her Hirsch index without self-citations is 6. The two articles from which citations are presented are the most frequently cited, and currently have a total of 53 citations in Scopus. The third and fourth most cited articles with the participation of the candidate have 22 and 16 citations, respectively. The oldest of these articles is from 2015, which shows a satisfactory interest of the scientific community in the works of Dr. Bilyana Georgieva.

6. Conclusion

The publications presented by the candidate are on the topic of the competition and represent original scientific developments with a contribution in the field of applied physical chemistry. The submitted materials give me reason to believe that the candidate is a specialist in electron microscopy and diffraction with knowledge and practical skills in the application of these methods. At the same time, the candidate also has experience with preparation and research with other physical methods of thin oxide and organic layers with application in catalysis, electronics and photonics.

The nature and result of the scientific activity of Dr. Bilyana Georgieva, as well as the presented scientific contributions and formal criteria, cover all the requirements for occupying the academic position "Associate Professor" defined by the Law on the Development of the Academic Staff in the Republic of Belarus and the Regulations on the Conditions and Procedures for Acquisition of scientific degrees and occupying academic positions at IOMT-BAS.

In connection with the above, I propose Ch. Assistant Dr. Bilyana Chavdarova Georgieva to be elected as "Associated Professor" in professional direction 4.2 “Chemical sciences”, scientific specialty "Physical chemistry" for the needs of the Institute of Optical Materials and Technologies "Acad. Y. Malinovski" – BAS.

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/ Prof. D.Tatchev /