PEER REVIEW

by Assoc. Prof. Reni Tomova, Ph.D. - Institute of Optical Materials and Technologies "Acad. J. Malinowski" (IOMT) – BAS

on Competition for an "Associate Professor" position at the IOMT – BAS in the professional field 4.2 "Chemical Sciences", speciality "Physical chemistry", announced in the State Gazette No. 35/01.05.2022.

1. General presentation of the received materials

Subject:

By Order No. 15-462/08.07.2022 of the Director of IOMT I was nominated as a member of the Scientific Jury of the competition for the occupation of the academic position of Associate Professor (area 4: Natural sciences, mathematics and informatics, professional field 4.2: Chemical Sciences, scientific speciality: "Physical chemistry"), announced for the needs of the "Institute of Optical Materials and Technologies"

Only one candidate has submitted documents for participation in the competition - Assistant Professor Dr. Biliana Chavdarova Georgieva from the Institute of Optical Materials and Technologies "Acad. Jordan Malinovski" - BAS.

The applicant has submitted all documents and materials required by the procedure of Art. 23 of the Rules of the Law for the development of academic staff in the Republic of Bulgaria (LDASRB) in IOMT. The documents certify that Dr Georgieva meets the conditions for occupying the academic position of "associate Professor" mentioned in Art. 22. (1) of the same regulation:

- According to item 1 - Dr Georgieva has an acquired educational and scientific degree "doctor" (diploma 000224/29.11.2012, awarded by BAS-IOMT);
- According to items 2a and 2b- Since March 2013, she has held the academic position of "Assistant Professor" in the "Electron Microscopy" Laboratory at the Scientific and Technical Department of IOMT, whose research team member she is until now (Certificate of work experience in the speciality);.
- Under item 3- For participation in the competition, she submitted 19 publications, which do not repeat those submitted for the acquisition of the educational and scientific degree "doctor";
- According to item 4 – With the 483 points she collected, she exceeds the minimum requirements of the BAS and the IOMT for occupying the academic position of "associate Professor" 430 points given in Appendix 1 Table 1 of the regulations.

2. A short biography of the applicant

Biliana Georgieva was born on November 29, 1974. She graduated with a master's degree in "Chemistry" at SU "St. Kliment Ohridski" with a specialization in "Particularly pure substances and materials based on them" in 1997. From 1999 until 2000 she works as a chemist in the sales department of the "MRAZ"-AD plant, Sofia. In 2000 started working as a chemist in the "Central Laboratory of Photo processes" - BAS (CLF from 2010-IOMT). From 2002 - 2004, she was a full-time doctoral student at the same institute. After her discharge, she continues her work at CLF. In 2007 won a competition and was appointed "research associate", a position transformed into "Assistant Professor" in 2010. In 2012, Biliana Georgieva defended her doctoral dissertation in the scientific speciality 01.05.01 "Physicochemistry" topic: "Vacuum deposited Sn-O-Te layers as sensors for moisture and reducing gases". In 2013 was appointed as an "Assistant Professor" in the "Electron Microscopy" Laboratory at the Scientific and Technical Department of IOMT, a position she holds till now.

3. General characteristics of the applicant's work

The scientific activity of the candidate is in the field of obtaining thin metal oxide films, and metal nanoparticles and studying their electrical, optical and gas sensor properties depending on their morphology, structure and phase composition by the methods of Transmission Electron Microscopy (TEM) and Electron Diffraction (SAED).

Dr Georgieva has a significant scientific output, well promoted in international journals and scientific forums. The total number of her publications is 56 with an h-index of 10 (Google Scholar Citations). She has participated in a total of 73 international scientific forums and schools (11 of them abroad), with 34 reports (4 of which were at the invitation of the organizers) and 39 posters. In addition, in the period 2011-2022, the candidate has taken part in 7 national projects with FNI (two of which she is the coordinator for IOMT), and she is the administrator for IOMT of the "National Center for Mechatronics and Clean Technologies" project, she is a member of the IOMT team at INFRAMAT and was the head of the project "Support of articles in refereed publications and publications with an impact factor" under the Operational Program "Development of Human Resources", co-financed by the European Social Fund.

4. Basic scientific contributions

To participate in the competition, Dr Georgieva has submitted 19 scientific publications, 13 of which are in Q1, Q2, Q3 and Q4 quartiles and 3 in journals with SJR factor, with articles No. 1 and 3 giving all 46 citations presented.

5. Major scientific contributions

5.1. Publications group of indicators "B", indicator "4": 5 items (No. 1-5)

The optical, sensor, catalytic, electrical, etc. functional properties of nanomaterials made of metal oxides depend on their morphology, crystal structure, phase composition, doping, etc., and method of preparation. In publications [1-5] (presented instead of a habilitation

thesis), the methods of Transmission Electron Microscopy (TEM) and Electron Diffraction (SAED) were applied to clarify the influence of the structure and composition of porous metal-oxide layers (from ZnO [1, 2], TiO2, SnO2 and MoO3[2]), nanocomposites (Ag/ZnO [1] and Au/ZnO [2]) and spinel oxides (ferrites and mixed ferrites of Zn [3], Ni [4] and Cu [5]) on their plasmonic and optical properties [1], sensitivity to various reducing gases and organic solvent vapours [2] and catalytic properties for methanol decomposition [3, 4 and 5].

The layers studied in [1 and 2] were obtained by the method of pulsed laser deposition with an Nd:YAG laser from undoped and doped oxide targets in the air [2] and in an oxygen atmosphere [1], and the latter were subsequently "annealed" with a different number of laser pulses. The layers in [3, 4 and 5] were deposited by decomposing (at high temperature) a methanol-impregnated solution of a mixture of Fe+3 nitrate and nitrates of Zn [3], Zn and Ni [4] and Zn, Ni and Cu [5] activated carbon carrier (derived from peach pits).

Main scientific contributions in publications "B" indicators

With the methods of TEM and SAED in the investigated layers it was established:

- The presence of silver nanoparticles in a nanostructured zinc oxide matrix and the possibility of modelling the properties of the layers by changing their morphology by processing with different numbers of annealing laser pulses have been demonstrated.
- The formation of highly porous metal oxide nanostructures from ZnO, ZnO doped with Au, TiO2, SnO2 and MoO3. The morphology, structure and phase composition of the layers were established and their sensitivity to vapours of reducing gases and organic solvents was proven.
- The catalytic activity of the active component (metal oxide particles) of the catalyst in the methanol decomposition process strongly depends on its phase composition and structure, which is easily controlled by the preparation procedure of the support on which it has been postponed (activated carbon obtained from peach pits).

5.2. Scientific contributions in the publications by group of indicators "G", indicator 7 - 14 issues (No. 5-19).

The articles in indicator "G" are divided into three different topics:

I. Resistive humidity sensing elements based on thermally vacuum deposited organic and inorganic thin films.

II. Application of TEM and SAED methods to characterize thin oxide films with controllable porosity of Nb, Ta and V, about their application as optical sensors for volatile organic vapours.

III. "Green" synthesis of silver nanoparticles. Application of TEM and SAED methods to study their morphology, structure and phase composition to find future applications in practice.

I. Resistive humidity sensing elements based on thermally vacuum deposited organic

and inorganic thin films.

Thin films of polyimide [6] and SnO2 [7] were obtained by thermal vacuum deposition from two sources: 4,4'-oxydianiline (ODA) and pyromellitic dianhydride (PMDA) for the polyimide [6] and Sn and TeO2 for SnO2 [7] and have been investigated as moisture sensors. The sensitivity of the films is due to the change in their electrical resistance as a result of the adsorption of water molecules. Polyimide films were found to have a rapid response at moisture concentrations (RH%) from 10 to 95%, independent of their thickness [6], indicating dominant surface physical adsorption. The application of TEM and SAED methods on SnO2 films shows the presence of finely dispersed phases of Te, Sn, TeO2 or SnTe in a SnO2 matrix in amounts dependent on the Sn/Te atomic ratio. The sensing properties of these films were investigated by impedance spectroscopy. The analysis of the obtained Nyquist plots shows the appearance of chemical adsorption of water molecules at RH% higher than 45% and of physical adsorption at RH% above 73% [7].

Contributions on topic I:

- New data were obtained on the type of adsorption of water molecules on the surface of thin polyimide and SnO2 films: physical for polyimide and chemical and physical for SnO2 films.

II. Investigation of optical sensors based on Nb-, Ta-V-oxide thin films, with tunable porosity by the methods of Transmission electron microscopy and electron diffraction

The articles included in this topic examine thin porous films of oxides of Nb [8-14], Ta [15, 16] and V [17] obtained by spin-coating of sols from precursors of the corresponding oxides and various polymeric materials (Pluronic, PEO, PDMA, PDMAA and their di- and tri-block copolymers). In this case, the polymer plays the role of an organic template, which, burning during the heating of the deposited gel at a high temperature (320^{o}C), forms in the film mesopores (2-50nm), the size of which depends on the type and concentration of the polymer in the zol. These films find application as optical sensors for the detection of vapours of volatile organic substances, as the condensation of vapours in the pores and/or change their thickness, transforming optical characteristics and films colour. TEM analysis shows that the size and number of pores in the film increase with increasing polymer concentration in the zol, which makes it possible to easily obtain layers of the same substance with different optical characteristics. In [17], Bragg stacks obtained by alternating layers of dense and mesoporous V2O5 as materials with high and low refractive index, respectively, were considered.

Contributions on topic II:

- By the methods of transmission electron microscopy and electron diffraction, the morphology and structure of dense and mesoporous thin amorphous films of Nb-, Ta- and V-oxides, obtained by centrifugation of zols of the corresponding oxides containing a polymeric organic template, are shown.

- The influence of the type and concentration of the template in the zol on the size and arrangement of the mesopores in the oxide films was studied.

- The phase composition of MFI-type zeolite synthesized by the hydrothermal method, used as a film in an optical splitter, including optical fibre and a Ta2O5 waveguide, has been proven.

III."Green" synthesis of silver nanoparticles. Application of TEM and SAED methods to study their morphology, structure and phase composition to find future applications in practice.

Silver nanoparticles obtained for the first time at "green" synthesis via reduction of an aqueous solution of AgNO3 with extracts from the waste flowers of Rosa Damascena [18], Achillea millefolium and Lavandula angustifolia [19] have been documented and investigated with the methods of Transmission Electron Microscopy and Electron Diffraction. The spherical shape and a polycrystalline structure of nanoparticles were established. For the first time, graphite electrodes coated with such nanoparticles were used for the amperometric detection and quantification of hydrogen peroxide and vanillin. Data on morphology, structure, phase composition and particle size distribution contribute to elucidating the relationship between their preparation conditions and their application.`

Contributions to topic III:

- For the first time the methods of Transmission Electron Microscopy and Electron Diffraction have been used to visualise the morphology and determine the structure and phase composition of silver nanoparticles obtained by a "green" method synthesis via reduction of AgNO3 with aqueous extracts from waste products in the essential oil industry of Rosa Damascena, Achillea millefolium and Lavandula angustifolia.

6. **Author's contribution to the articles presented in the competition**:

The works presented by the candidate are collective works, including several authors. Nevertheless, taking into account the well-structured and formulated contributions, I believe that Dr Georgieva has an undeniable personal contribution to obtaining the results related to TEM and SAED and shaping them in the publications. I have no critical remarks or recommendations for the candidate.

7. Pedagogical activity:

Assistant Professor Biliana Georgieva participated as a lecturer at the 9th and 10th Spring Seminar of PhD students and young scientists from BAS "Interdisciplinary Chemistry" (2016 and 2017) and the School of "Electron Microscopy" (2019) with lectures examining the methods of Transmission Electron Microscopy and Electron Diffraction and their areas of application. In addition, from 2014 until now, she has presented the Transmission Electron Microscope to a total of 19 groups of students and students from various schools and universities.

CONCLUSION

The documents and materials submitted by Assistant Professor Dr Biliana Chavdarova Georgieva, meet all the requirements of the Law on the Development of the Academic Staff

in the Republic of Bulgaria (LDASRB), the Regulations for its Application and the Regulations for its Application in IOMT. In the presented results there are enough scientific contributions, guaranteeing the successful future development of the research activity she started.

All this gives me the reason to give my positive assessment and to recommend the Scientific Jury to prepare a report-proposal to the IOMT Scientific Council for the selection of Dr Biliana Chavdarova Georgieva for the academic position of "Associate Professor" in district 4. Natural sciences, professional direction 4.2. Chemical sciences, scientific speciality "Physicochemistry".

Sofia, 28.08.2022

Reviewer: .....

Assoc. Prof. Dr. Reni Tomova