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REVIEW

in competition for an academic position "Associate Professor"

in the professional field 4.1 "Physical Sciences" (General Physics)

for the needs of Sofia University "St. Kliment Ohridski" (SU),

Physics Faculty, announced in State Gazette No. 21 of 15 March 2022.

prepared by. **Prof. Dr. Plamen Kostadinov Petkov**, Department of PHYSICS, University of Chemical Technology and Metallurgy, as a member of the scientific jury of the competition according to Order No. RD 38-248 / 20.05.2022 and Order No. RD 38-266 / 02.06.2022 of the Rector of Sofia University.

One candidate submitted documents for participation in the announced competition:

Assist. Prof. Dr. Gergana Emilova Alexieva, Sofia University, Faculty of Physics.

1. Application data

The documents submitted by the candidate for the competition comply with the requirements of the Law on Research and Development, the Regulations on the Conditions and Procedure for the Acquisition of Scientific Degrees and the Occupation of Academic Positions at Sofia University "St. Kliment Ohridski" (RUPASAADSSU).

The candidate has submitted a complete list of his scientific publications - 37: - articles in refereed journals - 25; articles in non-refereed journals - 12 and undoubtedly has an abstract of the PhD thesis.

For the participation in the competition assist.prof. Alexieva has submitted a list of 19 titles, including 19 publications in Bulgarian and foreign scientific journals and scientific forums and 3 textbooks. 7 other documents (in the form of official notes and certificates from an employer, project leader, funding organization or project sponsor and other relevant evidence) supporting the candidate's achievements were also submitted. The attached documents thus enable an objective assessment of the applicant's teaching and research activities.

2. Details of the applicant

Gergana Alexieva was born in Sofia in 1973. In 1992 she finished her secondary education at the 9th High School with French and Spanish "Alphonse de Lamartine", and since the autumn of the same year she has been a student at the Faculty of Physics of Sofia University "Kliment Ohridski". In 1997 he completed the five-year cycle of studies and graduated in Physics, specialization "Solid State Physics", defending brilliantly his thesis on "Immune biosensor based on a monolithic quartz filter".

In March of the following year, after a successful competition, she started her PhD program, again at the Faculty of Physics of Sofia University. During her PhD she specialized at the Technical University of Munich, F R Germany in the field of polymeric biosensors, naturally within the scope of her thesis topic. She defended her PhD thesis on : "Acoustic properties and applications of polymeric materials" in 2013 and after that was appointed to the AD "Principal Assistant Professor". Since 2020 she moved to the Department of General Physics, where she is currently working. Throughout her conscious life, Dr. Alexieva has been closely associated with the Faculty of Physics of the University of Sofia, in my opinion definitely contributing to the high quality of education in Physics and also scientifically active in the field of experimental Physics.

3. General description of the candidate's scientific works and achievements

The scientific interests of the assist.prof. Alexieva are in the field of Solid State Physics, and she focuses her research on acousto-optical and optical methods for the characterization of matter and properties of different groups of organic and inorganic materials. I would support the author's claim by identifying two main research areas in which she has made significant contributions: 'Exploring the potential of different materials for sensing and pharmaceutical applications' and 'Characterising the structure and properties of materials by acoustic, acousto-optic and optical methods'.

The materials in the competition fully meet the minimum national requirements, which the applicant exceeds by about 1.5 times (in group "C" - 119 points, in group "D" - 234 points and in group "E" - 102 points). The total number of independent citations of these articles is 52 , with a Hirsch index (h-index) of 5. The distribution of scientific articles by quartiles is very good and meets the additional requirements of the SU : - Q1 - 4 items [2, 3, 14, 16]1; - Q2 - 8 items [1, 6, 8, 10, 11, 15, 18, 19]; - Q3 - 3 items [7, 12, 13] and Q4 - 4 items [4, 5, 9, 17].

The experimental results of the habilitant are due also to the participation in scientific research projects funded by various sources - MES-NSF, SU "Kliment Ohridski", etc., in 5 of them he is a participant, and in one he is a supervisor. In the implementation of the projects, Dr. Alxieva has shown herself as a talented experimenter and undoubtedly a leading specialist in the “Acoustic Waves” Lab. and this judgment is a result from the author's position in the proposed articles.

The scientific papers presented by the candidate do not repeat those of previous procedures, both for the acquisition of the AP "Associate Professor" and for the acquisition of the "Doctor". This is quite understandable, as this is Dr. Alexieva's first habilitation, and moreover she does not even use the abstract of her dissertation, which has the rank of publication.

Having examined the scientific publications submitted for the competition, I declare with conviction that no plagiarism, signals or assumptions have been proven.

In conclusion, the scientific production meets the minimum national requirements (under Article 2b, paragraphs 2 and 3 of the RASRB Act) and the additional requirements of the St. Kliment Ohridski" for the academic position of Associate Professor in the scientific field and professional field of the competition.

4. Characteristics and evaluation of the candidate's teaching activity

The habilitant definitely possesses teaching talent and almost twenty years of experience working with students. The submitted work note certifies an average annual workload of more than 570 hours, which is an excellent reference considering that the norm is exceeded 1.5 times. On the other hand, one cannot miss the fact that Dr. Alexieva has prepared a number of diverse courses for students of various specialties, giving lectures, seminars and laboratory exercises on : "Physics of Condensed Matter" - seminar; "Crystallography and Crystallophysics" - seminar; "Polymers in Microelectronics" -practicum; "Acoustic and Optical Waves in Solid State" - practicum; "Electricity and Magnetism" - practicum; "Optics" - practicum; "Physics" - practicum; "Programming and Computational Physics" - practicum; "Modern Experimental Methods" - practicum; "Introduction to Programming" - practicum; Physics of Wave Processes - lectures and seminar; Fundamentals of Acoustics - lectures; Computer Methods for Data Processing - practicum; Geometric Optics - practicum; Medical Statistics - practicum; Data Processing - practicum; "Introduction to Astronomical Optics" - practicum; "Computer Modelling in Optics" - practicum; Physics lectures to the course "Physics and Biophysics" for Pharmacy major; "Physics" - lectures (Biology major). She has also developed three experimental exercises: Acousto-optic Diffraction; Piezoelectric Resonators and Thin Layer Deposition by Centrifugation. The candidate is the supervisor of two successful MSc thesis projects. This list gives me conviction to evaluate the pedagogical activity of the assist.prof. Alexieva as exceptionally good.

5. An essential analysis of the candidate's scientific and applied achievements contained in the competition materials

The results of the research have a definite scientific and applied character and can be classified as obtaining new data and proving existing hypotheses by new means. The main contributions can be systematized in two main directions as follows:

- Investigation with acoustic resonance devices of the capabilities of different materials for sensing and pharmaceutical applications

The capabilities of a number of polymers and metal oxides as working media for thin-film sensors have been investigated. Mainly piezo-resonance methods have been used characterized by a variety of functional capabilities, in accuracy and resolution superior to transducers implemented on other physical principles.

1. Data have been obtained on the sensitivity and adsorption capacity of the urethanimidine polymer in the detection of hexamethylenimine and pyridine [2, 3, 4, 5, 17, 19]. An original approach for "tuning" the sensitivity to pyridine by varying the layer thickness was also proposed. The obtained results also demonstrate the potential of the QCM method to be applied as a complementary method for measuring the gas permeabilities of different polymer matrices.

2. For the first time, data on the sensitivity of nanostructured ZnO, ZnO:Al and ZrO_2 layers to different analytes - NH_3, CH_3COOH, NO_2, C_2H_5OH, CH_3OH, pyridine and hexamethylenimine - were obtained [17,19]. The main experiment was carried out using a resonance method based on surface acoustic waves, which, due to its high sensitivity, is particularly suitable for the study of gas adsorption details.

3. The quartz microbalance method has been successfully applied in the development of drug carrier structures [9, 14]. A new drug carrier of bio-polyelectrolytes was fabricated representing a multilayer system of two polyelectrolytes, chitosan and xanthan. For the first time, this system was realized using a crystal resonator (10 MHz, AT-cut) embedded in a microfluidic platform. This allows the deposition of the film layers on the Au electrodes to be recorded in real time (over 1 s). The influence of pH and the addition of a crosslinking agent (glutaraldehyde) on the build kinetics, morphology (SEM) and stability of the system was determined. A method for quantification of drug content in polymeric microparticles was developed. The object of study were polymeric microparticles of ammonium methacrylate loaded (bearing in their porous structure) with the drugs Diltiazem and Lidocaine. An original QCM-platform of instrumentation was used, adapted to the structural specificity of the carrier and its aggregate state, as well as to the increased accuracy and repeatability requirements of

the measurements. The samples were deposited on the Au-electrode of the acoustic resonator (10 MHz, AT-cut) and the drug content was analyzed taking into account the changes of the resonance frequency due to the irreversible interaction of the drug molecules with the irradiating hydrochlorine gas.

- Characterisation of materials by acoustic, acousto-optic and optical methods

1. Using pulsed echo methods in the analysis of acoustic properties of materials [10, 13]. The acoustic velocities in crystals of iron-doped silenite ($Bi_{12}SiO_{20}$:Fe) as well as in a solid solution of Ag_4SSe.2PbTe were determined, and its isotropy was confirmed for silenite. For the first time, the acoustic and optical properties of a solid solution of Ag_4SSe.2PbTe were investigated. The results obtained from the echo measurements for the longitudinal and transverse wave velocities combined with the high value obtained for the refractive index in the near-infrared region of the spectrum are a prerequisite for the use of this material for piezoelectric delay lines and in IR acousto-optics.

2. The acousto-optic properties of piezoelectric composites based on PVDF and P(VDF-TrFE) polymers have been characterized [1]. The dependence of the properties on thickness and type andsize of nanoparticles -IF and ZnO. For the former composite, two diffraction maxima corresponding to longitudinal and transverse wave were recorded. The incorporation of IF-3 nanoparticles into the copolymer probably has a matrix stabilizing effect, associated with an increase in transverse "stiffness", and thus enhancing the corresponding electromechanical coupling coefficient. The absence of such an effect in the case of ZnO nanoparticles suggests a different organization in the matrix structure.

3. Optical characterization of different materials [6, 7, 8, 11, 12, 13, 15, 16]

New data on the optical properties - basic optical constants of oxide glasses based on Sb_2O_3, Te_2O, WO_3, PbO or Bi_2O_3 have been obtained. The optical properties of samples of the ternary chalcogenide As_2Se_3-Ag_4SSe-PbTe system (with different contents of its parts) were investigated in the ultraviolet, visible, near- and mid-infrared regions. Based on the spectra, the values of optical parameters (refractive index, extinction coefficient, absorption coefficient, optical forbidden zone, Urbach energy, dispersion energy) were estimated.

The influence of deposition temperature and substrate type on the structural and optical properties of electrochemically deposited ZnO and ZrO_2 layers, and doped zirconium oxide, respectively, was established. The average grain size was found to be slightly affected by temperature, while the morphology (SEM) varied from nano-wall and nano-rod grains at 50 °C, through nano-walls at 60 and 70 °C to hexagonal nano-rods at 80 °C. Temperature also affects the crystallographic growth directions and induces changes in the mechanical stresses of the

grown layers. The studied layers have high diffuse reflectance values in the spectral range of 400-900 nm. The ZrO_2 layers are deposited in different crystallographic directions. It is shown that the average roughness is mainly affected by the type of substrate and to a lesser extent by the deposition time, except for the layers deposited on indium tin oxide (ITO), due to the slower grain formation in this type of substrate. The obtained SEM micrographs, as well as the reflectance spectra, also show that the morphology of the nanostructured ZrO_2 layers depends on the substrate type with a slight difference in the dependence on deposition time for the layers deposited on ITO and SnO_2.

The results obtained for the properties of the films are important for their use in the development of light-emitting structures in optoelectronic and thin-film devices.

6. Critical comments and recommendations

I have no critical remarks. As a recommendations I would suggest two - to be more active in publishing (in relation to the forthcoming changes in the RRDA) and not to lose enthusiasm in future research.

7. Personal impressions of the candidate

I have no personal impressions of the candidate other than her publications. On the other hand, some of her co-authors have been my students or PhD students whose qualities are well known to me.

8. Conclusion on the application

After reading the materials and scientific publications submitted in the competition and based on the analysis of their significance and the scientific and applied contributions contained therein, I confirm that the scientific achievements meet the requirements of the Law on Research and Development, the Regulations for its application and the relevant Regulations of the University of St. Kliment Ohridski" for the academic position of Associate Professor in the scientific field and professional field of the competition. In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been found in the scientific publications submitted for the competition.

I give my positive evaluation of the application.

II. GENERAL CONCLUSION

On the basis of the above, I recommend that the scientific committee propose to the competent authority for the selection of the Faculty of Physics at the University of St. Petersburg. Kliment

Ohridski" to elect the Assist. Prof. Dr. Gergana Emilova Alexieva to hold the academic position of Associate Professor in the professional field 4.1 Physical Sciences (General Physics).

Sofia, 29.06.2022 .....

(Prof. Dr. Eng. Plamen Petkov)