REVIEW

for a competition for occupying the academic position "Associated Professor" in professional field 4.1. Physical sciences, scientific specialty "Electrical, magnetic and optical properties of condensed matter", announced in SG No. 35 of 10th May 2022 by the Institute of Optical Materials and Technologies (IOMT) - BAS

Applicant: **Dr. Velichka Yordanova Strijkova - Kenderova**, chief assistant at IOMT - BAS

Reviewer: **Dr. Tsvetanka Babeva** , professor at IOMT - BAS

1. Brief biographical data of the applicant

The sole applicant in the competition is Dr. Velichka Yordanova Strijkova-Kenderova, chief assistant at the Institute of Optical Materials and Technologies (IOMT) - BAS. In 1998, she graduated from the Faculty of Physics of Sofia University "St. Kliment Ohridski" with two majors - Master of Physics and Teacher of Physics. Immediately after graduation, she started as a physicist at the Central Laboratory of Photoprocesses (CLAPHOP) - BAS, and at the beginning of 2003 she was enrolled as a full-time PhD student. After finishing PhD studies, she was appointed successively at the positions of physicist, research associate 3rd degree (2007-2009), research associate 2nd degree (2009 - 2010), research associate 1st degree (2010 - 2011) and chief assistant at the CLAPHOP - BAS (from 2011 until now). From 2008 until now, she has been teaching physics and astronomy to junior high school and high school students, and in the period 2015 - 2019 she was a teacher of optics and optical devices at the Center for Professional Training "EUROOPTIC". In 2014, she defended her thesis titled "*Vacuum-deposited polyimide layers - properties and application possibilities* " and obtained PhD degree.

2. General description of the presented materials

The documents submitted by the applicant comply with the requirements of the ŽRASRB, PPZRASRB and the Regulations for the conditions and procedures for acquiring scientific degrees and occupying academic positions in IOMT - BAS. For participation in the competition, Dr. Strijkova submitted 19 scientific papers, all published in indexed scientific journals with an impact factor (IF). The high reputation of some of them is impressive which indicates high scientific quality*: International Journal of Molecular Sciences* (IF = 6.208), *Biosensors* (IF=5 .743), *Nanomaterials* (IF = 5.719), *Optics and laser technologies* (IF =4.939). The distribution by quartiles is as follows: **9** papers in journals with Q1 rank, **7** in Q2 and **3** in Q4.

As the equivalent of a habilitation thesis, Dr. Strijkova has presented 6 papers focused on the application of atomic force microscopy for *i*) quantitative and qualitative characterization of the mechanical properties and topography of red blood cells isolated from patients with various pathologies and *ii*) research of the relief of surface phase gratings obtained during polarization holographic recording in azopolymers and azopolymer nanocomposites.

From the presented materials, it can be seen that the applicant not only meets **the minimum national requirements** and those of BAS and IOMT – BAS but also exceed them:

group A – 50 points (out of at least 50 points), gained from PhD thesis

group V – 135 points (out of at least 100 points): publications No. 1, 2, 8, 11, 17, 19 from the list of publications (3 papers in Q1 journals and 3 papers in Q2)

group G – 262 points (out of at least 220 points): 13papers, 6 of them in Q1 journal, 4 in Q2 and 3 in Q4)

group D – 100 points (out of at least 50 point) : Dr. Strijkova participated in the competition with 50 citations.

All publications and citations of the applicant included in the present competition were not used in acquiring the PhD .

I do not detect any plagiarism in the submitted materials.

3. General characteristics of the basic scientific, applied scientific and teaching activity of the applicant

The research activity of Dr. Strijkova is related to the study of the topography and surface properties (electrical and mechanical) of various materials in the form of bulk samples or thin films, including the characterization of biological objects, in air, in an inert or liquid environment by means of Atomic Force Microscopy.

For her entire research career, Dr. Strijkova has co-authored 67 scientific papers, 41 of them are referred in WoS and/or Scopus. In the period after acquisition of PhD she participated in 26 national and international conferences with 27 poster and 11 talks in co-authorship. During the same period, she was a member of the working teams of 10 research projects.

Dr. Strijkova gained pedagogical experience during her long-term teaching of physics and astronomy in high school and junior high school, as well as during her work as a lecturer on optics and optical devices at the "EUROOPTIC" professional training center. I would like to note that Dr. Strijkova is one of the mentors of students from different schools and universities who conduct their practice at the Institute (and in recent years many such practices have taken place). In addition to the atomic force microscope, Dr. Strijkova is also person in charge for the optical 3D profilometer, which is also part

of the INFRAMAT distributed infrastructure. For the past three years, Dr. Strijkova has trained 18 students and specialists to work with this equipment.

4. Basic scientific and applied scientific contributions

The main contributions of the research, presented as the **equivalent of a habilitation thesis,** are related to :

I. Discrimination of morphometric and nanomechanical characteristics of erythrocytes in normal and pathological conditions using atomic force microscopy

(publ. Nos. 17 and 19 from the list of publications T.5)

- Using atomic force microscopy, specific morphological and nanomechanical parameters of erythrocytes of women with early pregnancy loss (EPL) of unknown etiology have been identified for the first time which discriminate them from healthy pregnant and nonpregnant women, the so-called control group. It has been established that membrane roughness and Young's modulus can be used as indicators of a pathological condition during pregnancy. Accelerated aging tests of EPL erythrocytes showed faster morphological transformation and earlier appearance of spiked and spherical cell shape, as well as reduced membrane roughness and elasticity with the evolution of aging [publ. No.17].

- For the first time, a comparison was made between the morphology and elasticity of the erythrocyte membrane of patients suffering from neurodegenerative diseases (Alzheimer's disease, Parkinson's disease and amyotrophic lateral sclerosis) and healthy cells. With the help of atomic force and optical microscopy, significant differences in the volume of disc-shaped cells, roughness and stiffness of the membrane, as well as differences in the aging process of the erythrocytes of sick and healthy patients were established. Some specific characteristics have also been established for individual pathologies, which can be used as biomarkers for their diagnosis [publ. No. 19].

II. Investigation of the period and amplitude of surface gratings obtained by polarization holographic recording in photoanisotropic polymer thin-film media

(publ. Nos. 1, 2, 8 and 11 of the list of publications T.5)

- Surface relief grating recorded in thin films of azopolymer PAZO ((Poly[1-[4-(3-carboxy-4-hydroxyphenylazo) benzenesulfonamido]-1,2-ethanediyl, sodium salt])) [publ. No.2] and azopolymer doped with ZnO [publ. No.1] and Au [publ. No.8] nanoparticles and goethite nanorods [publ. No.11] were studied using atomic force microscopy. The size and concentration of the particles, the thickness of the films and the period of the recorded gratings were varied and the influence of these parameters on the surface relief was followed. It is shown that the relief increases with doping and with increasing thickness, but there are optimal values of the thickness (about 1000 nm) and of the nanoparticle concentration.

The main contributions of the papers **outside the habilitation work** are related to the application of atomic force microscopy and optical profilometry for studying the topography and surface roughness of a wide variety of materials aiming at their optimisation for various modern applications:

I. Transparent conductive thin films of ZnO for application as transparent electrodes (publ. Nos. 3 and 10 of list T.5) **and piezoelectric nanogenerators** (publ. Nos. 6 and 12 of list T.5)

- Using atomic force microscopy, the topography and surface roughness of Al -doped ZnO (AZO) films obtained by Atomic Layer Deposition (ALD) on different substrates – glass, PET and mica [publ. Nos. 3 and 10] and films of Ga -doped ZnO (GZO) obtained by magnetron sputtering [publ. Nos. 6 and 12] were studied. It was found that the roughness of the AZO layers deposited on different substrates correlates with the substrate roughness and increases in the mica-glass-polymer direction. After applying 1000 bending cycles, the roughness of the AZO layers on mica did not change, while the films deposited on the polymer substrate increased their roughness twofold. For the GZO layers, the introduction of oxygen during deposition was found to decrease the surface roughness and the height of the sharp peaks.

II. 2D dichalcogenides of transition metals for optoelectronic applications (pub. Nos. 9 and 16 from list T.5)

- Atomic force microscopy was used to study the influence of the preparation conditions on the shape, size and distribution of WSe_2 flakes obtained by the TAC method (Thermally assisted conversion) [publ. No. 16], and 3D optical profilometry confirmed the good quality of WTe_2 crystals obtained by CVT (Chemical Vapour Transport) method and their suitability for further exfoliation [publ. No. 9]. By measuring the height of the WSe_2 flakes, the approximate number of layers was determined. It was found that at short deposition times triangular shapes with sharp edges predominate, which trasforms into dendrites and hexagons with increasing deposition time [publ. No. 16].

III. AlN layers obtained by atomic layer deposition for acoustic applications (publ. Nos. 7, 13 and 18 from list T.5)

- The morphology and surface roughness of AlN thin films obtained by atomic layer deposition on different substrates and temperatures were investigated. It was found that the smoothest layers are obtained on Si substrates covered with SiO_2, and the roughness does not depend on the temperature of the substrate and the number of deposition cycles.

IV. Polymer-dye composites as an active medium for lasers (publ. Nos. 5 and 15 from list T.5)

- An active laser medium consisting of a epoxy resin as a matrix with embedded laser dye (Rhodamine 6G and Rhodamine B) was developed. Atomic force microscopy has been used to elucidate the influence of morphology on the properties and generation

process of laser radiation. AFM studies on cross-sections show that the medium is homogeneous with an average grain size of about 130 nm. The presence of nano-sized channels between the grains, which act as a resonator, has been established.

V. Study of bio-active layers as media for biosensors (publ. Nos. 4 and 14 from list T.5)

- Hemoglobin and myoglobin layers deposited by MAPLE (Matrix-Assisted Pulsed Laser Evaporation) technology on both surface-relief gratings covered with Au thin layer, and smooth Si substrates, were studied by AFM. The optimal conditions for successful immobilization of hemoglobin and myoglobin molecules and formation of continuous films with preserved bioactivity were obtained [publ. No.4]

- With the help of atomic force microscopy, the virus-host interaction was followed, examining the morphological parameters of the cells (shape, size, state of the cytoplasm) before and after infection with human corona virus for several different times. The obtained results were used to clarify the mechanism of interaction during the different stages of infection [publ. No. 14].

5. Significance of the obtained results and personal contribution of the applicant

I am confident that significant results have been obtained that contribute positively to the field of materials science and have the potential for practical application. To confirm this, I will mention the fact that almost half of the papers presented in the competition were published in journals falling in the first quartile (Q1 in the respective field, which indicates a high quality of the results obtained.

The personal contribution of Dr. Strijkova is related to selection and optimization of the scanning parameters and conducting the measurements with the atomic force microscope, as well as in the processing and analysis of the results. I have known Velichka since the time she joined CLAPHOP, and I can say without hesitation that she is a very skillful and patient experimenter, which explains the fact that she was invited in many working teams as desirable collaborator.

6 . Critical notes and recommendations.

I have no critical remarks, neither to the submitted documents, nor to the presented reference of the scientific contributions.

CONCLUSION

The sole applicant in the competition, **Chief assistant Dr. Velichka Yordanova Strijkova - Kenderova**, has presented sufficient volume of materials that fully meets the minimum national requirements and those of the BAS and IOMT - BAS for the occupation of the academic position "Associated Professor". Dr. Strijkova's research activity is focused on studying the topography and surface properties of various materials in the form of bulk samples or thin layers, including the characterization of biological objects by means of atomic force microscopy aiming at their optimization for modern

applications. Original results have been achieved contributing positively on material science. Dr. Strijkova has also gained pedagogical experience through many years of teaching physics and astronomy in high school and junior high school.

On the basis of the above, I give my positive assessment and confidently recommend the honorable Scientific Jury to support the application and propose to the Scientific Council of IOMT - BAS to award Dr. Velichka Yordanova Strijkova - Kenderova the academic position "Associated Professor" in professional field 4.1.Physical sciences.

Sofia, 5th September 2022

Reviewer:

Prof. Dr. Tsvetanka Babeva