REVIEW

for a competition for acquiring an academic position "P**rofessor"**
in professional field 4.1 Physical Sciences (General Physics)
for the needs of Sofia University "St. Kliment Ohridski" (SU),
Faculty of Physics, announced in SG no. 24 of March 17th, 2023

The review was prepared by **Prof. Dr. Tsvetanka Krumova Babeva**, Institute of Optical Materials and Technologies "Acad. J. Malinowski" - BAS, professional field 4.1 Physical Sciences (Electrical , magnetic and optical properties of condensed matter) in her capacity as a member of the scientific jury for the competition according to Order No. RD-38-173/20.04.2023 of the Rector of Sofia University.

The sole applicant in the anounced competition is **Assoc. Prof. DSc Veselin Todorov Donchev**, Faculty of Physics of Sofia University.

I. General description of the application

1. Description of the presented documents

The documents presented in the competition by the applicant Associate Professor DSc Veselin Todorov Donchev comply with the requirements of ZRASRB, PPZRASRB and the Regulations for the terms and conditions for acquiring scientific degrees and occupying academic positions at Sofia University "St. Kliment Ohridski" .

To participate in the competition, Assoc. Prof. Veselin Todorov Donchev, DSc, has submitted a list of 22 papers in total, including 16 papers in impact factor journal and 6 full-text conference publications. The papers in the competition were not used for the acquisition of PhD and "Doctor of Sciences", nor for the acquisition of the academic positions "Chief assistant" and "Associate professor". A list of 113 citations was presented, again none of which had been used in previous competitions. The distribution of publications by quartiles is as follows: 8 in Q1 journals, 6 in Q2 journals and 2 in Q3 journals. The remaining 6 articles are in journals without IF or SJR. The papers have been published in prestigious international journals, for example, *Nano Letters* (IF=11.238), *ACS Omega* (IF =4.1) and *Applied Physics Letters* (IF =3.971).

In addition to the lists of articles and citations, 15 other documents are presented that support the applicant's achievements. They are described in details in the application for participation in the competition. They include: curriculum vitae, diplomas for higher education, PhD, associate professor and Doctor of Sciences; certificates for the occupied academic positions and for work experience;

certificate of educational employment; a list of all publications, conferences, projects and scientific management, generated by the Sofia University system called "Authors"; sample reference for the fulfillment of the minimum national requirements and the additional requirements of Sofia University; an auto-reference to the original scientific contributions; papers abstract in English and Bulgarian languages and a copy of the announcement in the State Gazette.

2. Applicant's record

Assoc. Prof. DSc. Veselin Donchev is a graduate of the Faculty of Physics of Sofia University "St. Kl. Ohridski", where in 1985 he graduated as a physicist with a specialization in "Solid State Physics", and in 1991 he obtained a PhD degree (called "candidate of sciences" at this time) in the field of physical sciences by defending a PhD dissertation on "*Investigation of electrical and optical properties of point defects in gallium arsenide*". In the same year, he started working as a physicist in the "Solid State Physics and Microelectronics" department at the Faculty of Physics of Sofia University. In 1993, he was appointed as a senior assistant in the "Physics of Condensed Matter" department of the Faculty of Science of Sofia University, where he successively held the positions of chief assistant (1997-2004) and associate professor (from 2004 to the present). Since 2013 he has been Head of the "Condensed Matter Physics and Microelectronics" department. During the period 2010-2013, DSc Donchev was an administrator at the European Commission (Brussels), being responsible for scientific projects under the Seventh Framework Programme in the field of nanoelectronics and micro-systems. During his career, DSc. Donchev has made eight scientific visits abroad lasting from 1 to 12 months. In 2021 he was a visiting scientist for 1 month at the Laboratoire de Génie électrique et électronique de Paris, Paris, France, and in 2008 for two months at the Department of Condensed Matter Physics, Institute of Physics "Gleb Wataghin" - UNICAMP, Campinas, Brazil. He also worked at the Department of Physics and Measurement Technology, University of Linköping, Sweden (12 months, 2002/2003), Department of Semiconductor Physics, Institute of Technical Physics, University of Erlangen-Nuremberg (2 months, 2002), Laboratory of Disorders and Heterogeneous Materials, University of Paris 6, (2 months, 2001), Faculty of Physics and Astronomy, University of St. Andrews (12 months, 1997/1998), Institute of Micro- and Optoelectronics, Ecole Fédérale de Lausanne, Switzerland (10 months, 1992/1993) and in the Solid State Physics Group, University of Paris 7 (6 months, 1992). In 2022, Associate Professor Donchev obtained the scientific degree "Doctor of Sciences" after defending a dissertation on the topic: "*Surface Photovoltaic Spectroscopy of Semiconductor Optoelectronic Materials and Nanostructures*".

3. General characteristics of the applicant's scientific work and achievements

The main research studies of Associate Professor DSc Veselin Donchev and the obtained results are in the field of condensed matter physics and are more specifically related to the study of the

electronic and optical properties of semiconductor materials and structures through photoelectric and optical experimental methods, as well as through computer simulations. Experimental equipment and measurement methodology for surface photovoltaic (SPV) spectroscopy have been created and pioneering SPV studies have been carried out on a number of semiconductor materials and structures to find application in photovoltaics and optoelectronics.

The scientific papers presented in the competition meet the **minimum national requirements** (according to Art. 2b, paras. 2 and 3 of ZRASRB) for acquiring the academic position of "professor" in professional field 4.1 Physical Sciences. The applicant's points by group are as follows:

group A - 50 points (out of at least 50 pts) – PhD thesis

group B - 100 points (not required) - dissertation for the scientific degree "Doctor of Sciences"

group V – 115 points (out of at least 100 pts) – 3 Q1 papers (F1, F3 and F5 from list 10B) and 2 Q2 papers Q2 (F2 and F4 from list 10B)

group G – 235 points (out of at least 200 pts) - 5 Q1 papers (F6, F7, F9, F11 and F12 from list 10B), 4 Q2 papers (F13, F14, F15 and F16 from list 10B) and 2 Q3 papers (F8 and F10 of list 10B)

group D – 226 points (out of at least 100 pts), collected from 113 citations that were not used in previous competitions

group E – 282 points (out of at least 150 pts), collected from: acquired scientific degree "Doctor of Sciences" (75 pts); supervision of a PhD student that has successfully passed viva (50 pts); participation in a national scientific or educational project (2 x 10 pts = 20 pts); management of a national scientific or educational project (20 pts); leadership of the Bulgarian team in an international scientific or educational project (2 x 50 pts = 100 pts); rising funds for projects led by the applicant (40,000 BGN = 8 pts) and published university textbooks (3 x (20 pts / 7 authors)= 9 pts)

According to the **additional requirements** of Sofia University "St. Kliment Ohridski" for occupying the academic position of "professor", the applicant **fully satisfies all criteria**, even surpassing most of them many times over.

As I have already mentioned, the scientific works presented by the applicant do not repeat those from previous procedures for acquiring a scientific degrees and academic position.

There is no proven plagiarism in the scientific works presented in the competition, nor is there any doubt about it. Most scientific papers presented in the competition are published in journals indexed in *Scopus* and *Web of Science* databases and have passed the mandatory plagiarism check.

4. Characteristics and assessment of the applicant's teaching activity

Prof. Donchev is a long-term university teacher. He has been delivering lectures in "General Physics (Mechanics)", "Molecular Physics", "Physical Foundations of Opto-Electronics" and "Nanostructured Materials and Instruments for Information Technologies" since 2004, as well as "Optoelectronic Instruments" since 2020. In the last 5 academic years, the average academic occu-

pancy of Assoc. Prof. Donchev is 430 hours, of which 363 are the average classroom occupancy. Since 2003 he has been the head of a student laboratory in electricity and magnetism at the Faculty of Physics of the Sofia University. DSc Donchev is a supervisor of two doctoral students (one alreadu finished and one still studying) and a consultant to two more. He supervised 6 graduates and was a consultant to four others.

5. Content analysis of the applicant's fundamental and applied scientific achievements contained in the materials for participation in the competition

The materials presented in the competition clearly show that a sufficient volume and quality of scientific research work has been carried out, the results of which has fundamental and applied scientific contribution to the field. This is proven by the independent citations of Assoc. Prof. Donchev - the reference in the *Scopus* database (July 10th 2023) shows 417 independent citations and an *h* - index equal to 9. Moreover, the received invitations to present the results at prestigious international forums show the interest of the international community to the results and research conducted by the applicant. Overall, I characterize the contributions as "*creating new methods and hypotheses and enriching existing knowledge in materials science and condensed matter physics*".

Research has been conducted on perovskites deposited directly on crystalline silicon without the use of additional tunneling or recombination layers (publ. F1 and F2). Using SPV (surface photovoltage) spectroscopy it has been proven the existence of two oppositely directed built-in electric fields in the structure. The spectral behavior of the measured SPV signal is explained by the interaction of the two processes of opposite sign generated by these two fields.

Using structural and optical methods, the degree of atomic ordering in InGaAsN layers obtained by liquid epitaxy has been investigated. A strong preference of In-N bonds in the crystal lattice was found, which represents an experimental confirmation of the previous theoretical assumptions of other authors (publ. F3).

Through liquid epitaxy at relatively low temperatures (<600^{o}C), GaAsSbN and GaAsSb layers were grown on n-GaAs substrates (publ. F4 and F5). Through SPV spectroscopy, the photoresponse of GaAsSbN was found to be weaker compared to that of GaAsSb, which was explained by the presence of point defects and recombination centers in GaAsSbN generated by nitrogen atoms.

A number of studies have been carried out on single and multiple InAs/GaAs quantum dots by investigating their micro photoluminescence upon excitation with two lasers, the main one tuned just below the band gap and the second one with low photon energy (IR laser) and used in addition to the main excitation laser (pub. F6-F10). It has been shown that an IR laser significantly affects the charge state of the quantum dots and their emission intensity. As the temperature of the crystal and the density of the quantum dots increase, the influence of the additional laser decreases. The effects are explained by the separate generation of additional electrons and holes provided by the second laser

excitation. It is suggested that the observed phenomena can be used to effectively manipulate the carrier collection efficiency and charge state of quantum dot-based optical devices.

Infrared transmission spectra of SiO_x layers ($x \leq 2$) containing amorphous or crystalline Si nanoparticles deposited on Si substrates were simulated using the Brugemann effective medium theory (pub. F11, K1 and K2). Two approximations have been used in the simulations: i) homogeneous mixture of Si and SiO_2 spheres and ii) SiO_2 matrix with Si spheres. The obtained results were compared with experimental IR spectra of SiO_x layers obtained by thermal evaporation in vacuum and appropriate subsequent heat treatment. From the comparison, important information was obtained about the composition of the layers, as well as about the density and homogeneity of the matrix.

Rolled-up semiconductor tubes of different diameters made of alternating InGaAs/GaAs layers were investigated using Raman scattering (publ. F12). The observed doublets of acoustic modes of the tubes in the low-frequency range, which are absent in the surrounding material, are taken as a clear evidence of the formation of periodic superlattices after the rolling-up process, and from them the quality of their interfaces can be judged.

Series of simulation and experimental studies have been conducted to study the influence of graded interfaces on the electronic structure and the wave functions of V-shaped GaAs/AlGaAs quantum wires (publ. F13, F14, K3, K4 and K5). The interface grading is successfully modeled by a concentration profile due to interdiffusion across the interfaces. The obtained results show that the energy levels and localization of the wave function in quantum wires can be modified in a controllable manner by deliberately induced inter-diffusion of material components across the interfaces. In this way, their optical properties can be adjusted for applications in integral photonic devices.

Using an original experimental technique of surface photovoltage spectroscopy at temperatures from 65 to 300 K, the diffusion length and surface recombination rate of minority current carriers in a p-Si coated with sol-gel composite layer of Al_2O_3 –TiO_2 were determined (publ. F15).

Electronic states in AlGaN/GaN multiple quantum wells (publ. F16), which are building blocks of the active regions of UV-emitting LEDs, are studied. The influence of interface roughness and electric charge due to internal polarization fields has been investigated.

An original approach has been proposed to open a significant energy band gap in a single-junction GaAs solar cell using an array of InAs quantum dots whose shape and size are optimized to result in ultrahigh cell efficiency under concentrated light (publ. K6).

All papers (22 in total) presented in the competition are co-authored, and in 17 of them Associate Professor DScVeselin Donchev has made a significant contribution (meaning according to the criteria of the Faculty of Physics of Sofia University). According to the submitted auto-estimation

of contributions, his personal contributions are mainly in planning of experiments, measurements and interpretation of SPV and photoluminescence spectra, discussion of results, writing computer codes to simulate the optical transmission spectra of effective media, writing parts of the papers and final overall preparation of those in which he is a corresponding author.

6. Critical remarks and recommendations

I have no critical remarks, neither to the materials presented, nor to the formulated contributions of the applicant.

7. Personal impressions of the applicant

I have known DSc Donchev for more than 10 years and I have excellent impressions of him. I consider him an erudite physicist and scientist, a skillful experimenter and a thorough researcher who always strives to get to the heart of the problem and pays attention to the smallest details.

8. Conclusion

After I have studied the materials and scientific papers submitted in the competition and on the basis of the analysis of their importance and their fundamental and applied scientific contributions, **I confirm** that the scientific achievements **meet** the requirements of ZRASRB, the Regulations for its application and the relevant Regulations of Sofia University "St. Kliment Ohridski" for holding the academic position “Professor” by the applicant in professional field 4.1 Physical Sciences (General Physics). In particular, the applicant **satisfies the minimum national requirements** and the additional requirements of the Faculty of Physics of Sofia University "St. Kliment Ohridski" in the professional field mentioned above and no plagiarism has been found in the scientific works presented in the competition, nor is there any suspicion of such plagiarism.

I give my **positive** assessment to the application.

II. GENERAL CONCLUSION

Based on all above, **I recommend** the scientific jury to propose to the Faculty Council of the Faculty of Physics of Sofia University "St. Kliment Ohridski" to select **Associate Professor DSc Vesselin Todorov Donchev** to occupy the academic position of "P**rofessor**" in professional field 4.1 Physical Sciences (General Physics).

July 10th 2023 Reviewer: .....

(Prof. Dr. Tsvetanka Babeva)