

OPINION
of a dissertation
for the acquisition of a scientific degree "Doctor of Sciences"
in professional direction 4.1 "Physical Sciences",
by defense procedure at the Faculty of Physics (FzF)
of Sofia University "St. Kliment Ohridski" (SU)

The review was prepared by: Prof. DSc. Miroslav Vergilov Abrashev – FzF, SU, in his capacity as a member of the scientific jury according to Order No. RD 38-464 / 27.07.2022 of the Rector of Sofia University.

Dissertation topic: "Surface photovoltaic spectroscopy of semiconductor optoelectronic materials and nanostructures"

Author of the dissertation: Associate Professor Dr. Veselin Todorov Donchev

I. General description of the presented materials

1. Data on the submitted documents

The candidate Veselin Donchev has submitted a dissertation and an Author's abstract, as well as the mandatory tables for the Faculty of Physics from the Regulations for the conditions and procedures for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski". 2 other documents (in the form of official notes and certificates from an employer, project manager, funding organization or project contractor, references and reviews, awards and other relevant evidence) supporting the applicant's achievements are also presented.

The documents presented by the candidate for the defense correspond to the requirements of the ZRASRB, PPZRASRB and the Regulations for the terms and conditions for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski" (PURPNSZADSU).

2. Applicant data

Veselin Donchev graduated in "Physics" with a specialization in "Solid state physics" at the Faculty of Physics of the SU in 1985 with an excellent grade of 5.97. In 1991, he received the scientific degree "doctor" ("candidate of physical sciences") with the thesis "Investigation of electrical and optical properties of point defects in gallium arsenide" (with scientific supervisor Prof. Krasimira Germanova). Since 1991, he has worked in the Faculty of Science of the SU successively as a physicist (1991-1992), senior assistant (1993-1997), ch. assistant professor (1997-

2004) and associate professor (2004-present). In the period 2010-2013, he worked as an administrator at the European Commission in Brussels (administration of scientific projects in the field of nanoelectronics and microsystems). As a lecturer, he led both courses in General Physics ("Mechanics" and "Molecular Physics"), as well as specialized courses "Nanostructured Materials and Instruments for Information Technologies" and "Physical Foundations of Optoelectronics") in the M.Sc. program "Microelectronics and Information Technologies". He is the head of the teaching laboratory "Electricity and Magnetism" (2004-2010 and 2013-present). Head of the Department "Condensed Matter Physics and Microelectronics" (2013-present). Supervisor of 1 defended and 1 current doctoral student, consultant of 2 doctoral students, supervisor of 6 and consultant of 4 graduate students. His main research interests are in the field of electronic and optical properties of semiconductor materials and structures. He has carried out 8 long-term scientific visits with a total duration of 48 months to various universities and research centers in France, Germany, Switzerland, Sweden, Brazil and Scotland.

3. General characteristics of the candidate's scientific achievements

The scientific results presented in the dissertation are in the field of electronic and optical properties of semiconductor materials and nanostructures. The main research method used is surface photovoltage (SPV) measurement. The dissertation's contributions are: in the design and creation of an experimental setup for SPV measurements, in the interpretation of the obtained results (including interpretation of the SPV phase spectra, definition of the zero value of the phase, the relationship between its change and the change of the electronic energy zones in the semiconductor) of different types of semiconductor nanostructures.

Reasonably and definitely it can be said that:

- a) the scientific publications included in the dissertation meet the minimum national requirements (according to Art. 2b, paras. 2 and 3 of ZRASRB) and, accordingly, the additional requirements of SU "St. Kliment Ohridski" for the acquisition of a scientific degree "Doctor of Sciences" in the relevant scientific field and professional direction;
- b) scientific publications included in the dissertation work do not repeat those from previous procedures for acquiring a scientific title and academic position;
- c) there is no proven plagiarism in the submitted dissertation and abstract.

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

Using surface photovoltage spectroscopy, two groups of materials have been investigated: nanostructures for optoelectronic applications and materials with applications in photovoltaics. The first group includes the materials AlAs/GaAs superlattices with GaAs embedded quantum wells, interdiffuse InAs/InGaAlAs structures with quantum dots in quantum wells, structures with InAs quantum dots in quantum wells, and multilayer structures with InP/GaAs type-II quantum dots. The

second group includes silicon nanowires prepared by metal-assisted chemical etching and GaAs-based rarefaction nitrides. From the interpretation of the obtained SPV spectra, important information about the electronic structure and electronic transport in these materials was obtained: values of the shift of the energies of optical transitions, change of the concentration of recombination centers, dominant mechanisms of radiative recombination. The obtained results have both fundamental value (they deepen the knowledge of complex semiconductor nanostructures) and applied value (they contribute to the creation and control of new optoelectronic and photovoltaic devices).

From the information presented by the dissertation, the following scientometric data for the dissertation and the author are established:

The dissertation includes 14 articles from group I and 6 from group III, in total 19 the dissertant has made a significant contribution. 117 citations of articles included in the dissertation are presented. The total number of citations of the dissertant is 382 (SCOPUS), and the h-index is 9.

5. Critical notes and recommendations

I have no significant critical remarks on the dissertation and the abstract. I have two questions for the dissertant that arose in the process of reading the materials:

1. In the description of the experiment for measuring the surface photovoltage (SPV) (Abstract, p. 5) it is stated that a Golay detector "which has a flat spectrum" is used to stabilize the photon flux. However, the spectral sensitivity of the detector is constant in respect to the energy of the light (since it is a photothermal detector), and at constant energy the photon flux will grow proportionally to the wavelength of the monochromatic light used. Has this fact been accounted for?
2. The vector method of representing the SPV signal assumes that the two "vectors" provide information about independent (non-influencing) one another processes. Has this been accomplished in all experiments conducted?

6. Personal impressions of the candidate

I have known Veselin Donchev since October 8, 1983. My impressions of him as a scientist, teacher and colleague are excellent.

7. Conclusion

After having familiarized myself with the presented dissertation work, Abstract and other materials, and based on the analysis of their significance and the scientific and scientific-applied contributions contained in them, I **confirm** that the scientific achievements meet the requirements of ZRASRB and the Rules for its application and the relevant Regulations of the SU "St. Kliment Ohridski" **for acquiring the scientific degree "Doctor of Sciences"**. In particular, the candidate

satisfies the minimum national requirements in the professional direction and no plagiarism has been found in the dissertation, abstract and scientific works submitted for the competition.

I give my **positive** assessment of the dissertation work.

II. GENERAL CONCLUSION

Based on the above, I **recommend** that the scientific jury **award the scientific degree "Doctor of Sciences"** in professional direction 4.1 "Physical Sciences" to Assoc. Dr. Veselin Todorov Donchev.

25.08.2022 г.

Prepared the review:

(prof. DSc Miroslav Abrashev)