

**REPORT**  
**for dissertation for awarding scientific degree**  
**"Doctor of sciences" in professional field**  
**4.1 Physical sciences (Physics of condensed matter),**  
**according to the defense procedure at the Faculty of Physics**  
**of Sofia University "St. Kliment Ohridski" (SU)**

The report was prepared by **Prof. Dr. Tsvetanka Krumova Babeva**, Institute of Optical Materials and Technologies "Acad. Y. Malinowski" – Bulgarian Academy of Sciences in her 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 title: "Surface photovoltage spectroscopy of semiconductor optoelectronic materials and nanostructures"**

**Author of the dissertation: Associated Professor Dr. Veselin Todorov Donchev**

**I. General description of the presented materials**

**1. Description of the applicant's documents**

The applicant Assoc. Prof. Dr. Veselin Todorov Donchev has submitted a dissertation in English and a synopsis in Bulgarian and English, as well as the mandatory tables for the Faculty of Physics from the Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions in SU "St. Kliment Ohridski". The presented set of documents also includes a curriculum vitae, diplomas of higher education and PhD degree, declaration of authorship and full text of the publications included in the dissertation.

The documents submitted by the applicant comply with the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria and the national rules and the regulations of Faculty of Physics -Sofia University for its implementation.

**2. Applicant's short biographical data**

Assoc. Prof. Dr. 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 the SU, 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, Dr. 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, Dr. 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) .

### **3. General description of the applicant's scientific achievements**

The main achievements of Dr. Donchev are in the field of investigation of electronic and optical properties on semiconductor materials and structures through photoelectric and optical experimental methods as well as through computer simulations. The research conducted in the dissertation and the obtained results are related to the construction of experimental equipment and developing of measurement methodology for surface photovoltage spectroscopy of materials and structures that could find application in optoelectronics.

A total of 24 scientific papers are included in the dissertation, 21 of which are indexed in WoS and Scopus databases. The fact that the papers were published in respected scientific journals makes a very good impression. The distribution by quartiles is: 9 in Q1, 6 in Q2, 2 in Q3 and 4 in journals with SJR and without IF. I will not take it into account in the review the

paper F1, because according to the self-report on the fulfillment of the minimum national requirements (table D3), publication F1 of the dissertation was used for awarding the academic position "Associated professor". Nevertheless the papers of Dr. Donchev included in the dissertation not only meet the minimum national requirements (according to Art. 2b, Para. 2 and 3 of the Act on Development of the Academic Staff in the Republic of Bulgaria), but significantly exceed them: 390 points out of at least 100 for group G, and 232 points out of at least 100 for group D. According to the additional requirements of Faculty of Physics of Sofia University they are also fully met: 14 publications in Group I publications (i.e. publications in journals Q1 and Q2), and in 13 of them (a minimum of 9 are required) Dr. Donchev has made a significant contribution. The number of independent citations of Dr. Donchev's papers for the competition is 113, with a minimum requirement of 100, and his  $h$  - index is 9 with a minimum requirement of 6.

As I have already mentioned, the scientific publications included in the dissertation do not repeat those used in previous procedures for acquiring PhD degree and the academic position "Associated professor". From the originality verification report of the dissertation, which was additionally sent to us, it is clear that there are no signs of plagiarism. Considering also that all the results are published in reputable journals after being peer-reviewed and checked for plagiarism, I strongly reject any possibility of plagiarism.

#### **4. General description of the applicant's teaching activity**

Dr. Donchev is a long-time university professor. Since 2004 he has been delivering lectures in "General physics (mechanics)", "Molecular Physics", "Physical Foundations of Opto-Electronics" and "Nanostructured Materials and Instruments for Information Technologies", as well as "Optoelectronic Instruments" since 2020. He has been Head of a student laboratory of electricity and magnetism at the Faculty of Physics of SU since 2003. Dr. Donchev has been the supervisor of two PhD students (1 defended and 1 present) and consultant to another two. He supervised 6 graduates and was a consultant to four others.

#### **5. Analysis of the applicant's pure and applied scientific achievements and contributions**

*The pure scientific contributions* of the dissertation can generally be characterized as the *development of new hypotheses and methods*: 1) development of an experimental setup and measurement procedure for SPV (*surface photo voltage*) measurements in a wide spectral range and at different temperatures; 2) development of two approaches for extracting information from the phase of the SPV spectra, applied to determine the semiconductor type

( $p$  or  $n$ ) and to relate the phase spectrum to the absorption spectrum (similar to the amplitude spectrum); 3) development of a combined analysis of the amplitude and phase SPV spectra for correct interpretation of complex experimental data; a vector model of the SPV signal was proposed, especially useful when more than one SPV generation process occurs in the same spectral range leading to complicated SPV spectral features.

I classified *applied scientific contributions* as *enrichment of existing knowledge and obtaining new ones*. The results were obtained through the study of various materials and nanostructures using developed equipment and methodology. Materials were selected from the viewpoint of their possible application in optoelectronics and photovoltaics technology. Exciton transition energies in AlAs/GaAs superlattices with embedded GaAs quantum wells were determined and very good agreement with values obtained from photoluminescence spectra and those from theoretical calculations was obtained. Si nanowires obtained by metal-assisted chemical etching were studied and it is shown that the chemical treatment with HF / piranha / HF strongly reduces the surface recombination centres produced by the etching process increasing in this way the carrier diffusion length twice. Diluted nitrides based of GaAs grown with liquid phase epitaxy were studied by SPS (*Surface photovoltage spectroscopy*) and PL (*Photoluminescence*) and important information regarding their possible application was obtained. For example: the addition of In in GaAs has been shown to reduce the band gap because it promotes nitrogen incorporation in the crystal lattice affecting the bottom of the conduction band. A similar reduction in the band gap is also observed upon inclusion of Sb, which is primarily due to its effect on the valence band edge. The observed anti-Stokes shift between absorption and emission of InGaAs(Sb)N layers has been explained by absorption via N-induced defect states near the conduction band edge. The fundamental band edge of the first LPE-grown solar cells based on GaAsSbN compensated by Mg doping was determined and a very good agreement was found with the spectrum of the external quantum efficiency.

## **6. Critical remarks and recommendations**

I have no any amendments and recommendations.

## **7. Personal impressions of the candidate**

I have excellent impressions of Dr. Veselin Donchev. I consider him a very good physicist, a skillful experimenter and a precise researcher who always strives to get to the heart of the problem and pays attention to the smallest details.

## 8. Conclusion

After having familiarized myself with the presented dissertation, synopsis and other materials, and based on the analysis of their significance and the pure and applied scientific contributions contained in them, I **confirm** that the scientific achievements meet the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria and the Rules for its application and the relevant Regulations of the Sofia University "St. Kliment Ohridski" for the **acquisition of the scientific degree "Doctor of Sciences"**. In particular, the applicant satisfies the minimum national requirements in the professional field and no plagiarism has been found in the dissertation, synopsis and scientific papers submitted for the defence.

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

## II . GENERAL CONCLUSION

Based on the foregoing, I recommend the Scientific Jury **to award the scientific degree "Doctor of Sciences"** in a professional field. 4.1 Physical Sciences (Physics of Condensed Matter) to **Associated Professor Dr. Veselin Todorov Donchev**.

23<sup>th</sup> September 2022

Reviewer: .....

(Prof. Dr. Tsvetanka Babeva)