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REVIEW

on a competition for the occupation of the academic position Associate Professor in the field 4.1. "Physical Sciences" (Electrical, magnetic and optical properties of condensed matter), for the needs of the Faculty of Physics at the University of Sofia according to the announcement in NS No. 93 of 26.11.2019 with a candidate: Kiril Mladenov Kirilov, PhD, Assistant Professor at the Department of Solid State Physics and Microelectronics (now Condensed Matter Physics and Microelectronics) at the Faculty of Physics.

Reviewer: Vesselin Strashilov, Professor, Doctor of Physical Sciences, Retired

1. Brief biographical information.

The candidate has a master's degree in physics, majoring in engineering physics, and a professional qualification as an engineer-physicist from the Faculty of Physics at Sofia University “St. Kliment Ohridski ”since 2001. In the period 2003-2006 he is a full-time doctoral student at the Department of Solid State Physics and Microelectronics of the Faculty with scientific supervisor Assoc. Prof. Kr. Germanova. He defended his doctoral thesis on "Characterization of semiconductor bulk and nanostructured materials by surface photovoltaic spectroscopy" in 2008. He has worked consecutively as a physicist and assistant professor in the department.

2. General description of the materials presented.

The candidate participates in the competition with a total of 16 works, which are articles in indexed journals published after 2008. According to the requirements, this group does not include the 5 indexed publications used in his doctoral dissertation and published by 2007. With the diverse thematic nature of research, there is no basis for duplication of results in the publications. The total number of papers, including indexed and non-indexed publications and conference reports, is much higher. A detailed, divided to directions and sub-directions author's report on his scientific contributions, as well as data on his long-term pedagogical activity are presented.

3. Assessment of the applicant's compliance with the minimum national requirements and the requirements of the Faculty of Physics according to the attached table.

All of the publications in question have been published since graduation. The applicant submits data on their points according to the SCOPUS classification, taking into account the metric of the years of publication.

Group B contains 4 publications from journals in Group Q1 (Applied Surface Science, Semiconductor Science and Technology, Review of Scientific Instruments, and Physica Status Solidi A).

Group Д presents: 2 publications with Q1 (Journal of Physics D: Applied Physics and Semiconductor Science and Technology), 3 with Q2 (Materials Research Express, Materials Chemistry and Physics, and Colloids and Surfaces A: Physicochemical and Engineering Aspects), 6 with Q3 (Journal of Physics: Conference Series (3), Physics Education and Physica Status Solidi C (2)), and 1 with Q4 (Bulgarian Chemical Communications).

The candidate has submitted a total of 89 independent quotes, of which 50 for group Д in the table. In SCOPUS, his total quotations are 160, with the base work: V. Donchev, K. Kirilov, Ts. Ivanov, K. Germanova, "Surface photovoltage phase spectroscopy - a handy tool for characterization of bulk semiconductors and nanostructures", Materials Science and Engineering B: Solid State Materials for Advanced Technology 129 (1-3) 186-192 (2006), which is from his doctoral thesis, having been cited 96 times, which is a remarkable achievement. In fact, in defense of his dissertation, he had only 2 citations. The quotes are in indexed journals abroad and I see no reason for reduction in this regard. The H-index of works without self-citations is set to 5. The total number of points by groups of indicators, which is obtained after taking into account the above features, is presented in the table below. The results speak eloquently that the applicant meets the minimum national requirements. At the same time, the pedagogical information mentioned below (p. 5) is in accordance with the additional recommendations of the Faculty of Physics in this regard that were in force at the date of submission of the materials.

Comparative data on the minimum required points by groups of indicators for the specific competition and the applicant's scientometric data.

Type of indicators	Content	National regulations	Applicant's data
А	Indicator 1	50	50
Б	Indicator 2	-	-
В	Indicator 4	100	100
Г	Sum of indicators 5 to 9	200	212
Д	Sum of indicators 10 to 12	50	100
Е	Sum of indicators 13 to end	-	-

4. General characteristics of the applicant's scientific and applied activities.

Kiril Kirilov is a professional in the field of solid-state optics, in particular semiconductor optics. A testimony to this is the very professionally written and detailed reference to his

contributions. Along with solid knowledge, the priority of his activity is experimental research with different methods - optical (photoluminescence, cathodoluminescence, Raman spectroscopy, optical transmission) and electrical (specific resistance, voltammetric characteristics), as well as processing of the obtained results and participation in discussions on them. He divides his field of activity into two groups - new materials and new methods, but I think this division is rather conditional, since the two are obviously linked. Otherwise, the relevance of his research is beyond doubt, since the object - nanostructured materials (thin layers and nanoparticles) - is the core of modern optoelectronics. The methodological side also sounds modern - growth of materials and their studies with a series of experimental techniques - Raman spectroscopy, photoluminescence, transmission, XRD, ATM, XPS, SEM, TEM and more. Some of the studies were performed at low temperatures.

5. Pedagogical activity of the applicant.

As an Assistant Professor, the applicant develops a substantial teaching activity by participating in: Exercises on "Basic Computer Knowledge", "Fundamentals of Programming", "Advanced Experimental Methods", "General Physics", "Physical Electronics 2 - Solid Electronics" and a Practicum in Solid State Physics and Microelectronics"; Lectures on "Experimental Physics", "Practical Physics", "Experimental Methods in Solid State Physics". According to the data from the Rectorate of the Sofia University, in the last three academic years, an increase in the number of hours taken (from over 400 in the first to over 600 in the last year) has been realized in these disciplines, which exceeds the norms accepted for the university. 3 Bachelor's and 1 Master's Degrees have been conducted. He has also participated in educational activities with pupils. One of the candidate's publications is in this field (a method of measuring the density of non-dipped granular materials) was used to select pupils with best experimental skills in the 2011 National Olympiad in Physics with a view to their participation in an International Olympiad.

6. Basic scientific and applied scientific contributions.

In a synthesized form, I can see the following main research contributions in the applicant's work:

- Pulsed laser deposition of thin carbon layers on silicon substrates with properties similar to nanosized graphene of good crystalline quality. Synthesis of graphene oxide by solution polymerization by the new bottom-up method. Obtained domains larger than those by other authors. In both methods, bond hybridization has been extensively investigated and used.

- Growth of amorphous silicon nanoparticles and nanocrystals of various sizes by thermal vacuum evaporation of SiO on crystalline Si and subsequent annealing at different temperatures. Two types of nanoparticles have a different mechanism of transport of carriers.

- CdSe nanocrystals were obtained by hot injection into liquid paraffin, whose photoluminescent spectra were studied at low temperatures. The behavior of the exciton emission lines leads to conclusions about the properties and sizes of the particles isolated at different stages of nanocrystalline growth.

- The capabilities of the liquid phase epitaxy method for the growth of bulk layers of dilute nitrides of good optical quality have been demonstrated.

- Grown up by different methods are a series of layers of the now-developed InN material, whose properties have been studied by Raman spectroscopy, photoluminescence, electron

microscopy and X-ray diffraction. The influence of the method of growth on the width of the band gap was established and correlation between the optical properties and the crystal quality was made.

- Transition energies in a sample containing multiple quantum wells of GaN / InGaN grown through MOCVD have been investigated theoretically and experimentally. The experimental study of the structure was done by cathodoluminescence. Splitting of the cathodoluminescent peak is associated with fluctuations in the width of the wells coming from roughness of the interfaces.

- Negative differential conductivity has been observed in strained AlN / GaN superlattices in a direction perpendicular to the layers, indicating resonance tunneling across the barriers.

- A new vector model has been developed for the analysis of the amplitude and phase of the surface photovoltaic (SPV) spectra. The SPV signal is represented as a vector of magnitude equal to its amplitude and an angle to the axis x equal to its phase. This model is applicable to the study of complex nanostructures where more than one process occurs during spectrum measurement. It helps, for example, to explain the contradictory spectra of AlAs / GaAs superlattices with embedded GaAs quantum wells grown on different GaAs substrates.

- An original adapter between the optical fiber and the vacuum chamber is proposed. It has been tested by cathodoluminescent studies under low pressure of GaN single crystals. It has also been used in other published studies using this method.

- Simulations have shown that changes in the refractive index induced by the electron beam in an electron microscope can be detected experimentally by optical methods, and in particular by ellipsometry. This combined technique allows the visualization of the thermal characteristics of small objects with micron resolution. It is further shown that with real powers and a well-focused beam it is possible to achieve sufficiently high temperature changes of the order of 500 K. Hence, from a relative change in the reflection coefficient with temperature of the order of 10-5 K^{-1} it follows that, using a phase-sensitive technique, the discussed relative changes in reflection caused by temperature changes can be considered measurable.

The analysis of these contributions shows that, in the face of the diverse activity and the weight of the results obtained, it is difficult to define a particular direction in the nomenclature - there is a formulation (justification) for a new scientific problem; creation of new classifications, methods, constructions, technologies; obtaining and proving new facts, as well as elements of new applications.

7. Reflection of the candidate's scientific publications in our and foreign literature.

This information is given in detail in paragraph 3 and shows a strong scientific interest from the optoelectronic society.

8. Contribution of the candidate to the collective publications.

It is evident that the candidate adheres to the contemporary style of working in teams, some of which are broad. Apart from Assoc. Prof. K. Germanova, his collaboration with Prof. E. Valcheva and Assoc. Prof. V. Donchev is particularly important. In this style, where each participant contributes his or her specific knowledge and skills, it is generally difficult to identify someone's contribution as being particularly significant or, above all, leading. I can confidently claim that the applicant is an excellent experimenter in the fields of surface photovoltaics (SPV), Raman and fluorescence spectroscopy, and has a solid knowledge of semiconductor physics and optics. This inevitably defines his involvement in publications

as essential. He himself has focused on two of the works, where we can therefore speak of this involvement as being particularly significant. One of them, related to the development of the vector model for the analysis of the SPV amplitude, is of wide interest and much cited. The other - the development of an optical fiber adapter - is almost entirely his business.

9. Critical notes of the reviewer.

Contest materials are very detailed and precise. This applies in particular to the comprehensive reference to the scientific contributions. The habilitation report, which is to be drawn up in accordance with Note 12 of the rules of the law, is missing. I think this is a pass that should not be blamed on the applicant's fault, but due to lack of awareness. These are the first competitions under the new law and regulations, and not all colleagues are fully aware of their requirements. The important thing for me in this case is that the applicant has enough serious scientific contributions that allow the selection of several thematically related works, for example in the field of properties and research of nanostructured materials obtained with different modern methods (option 1), or nitride materials (2) with appropriate justification for relevance and innovation. It should not be because of such a formal lack that the appreciation should be suffering undeservedly and I will not take it into account in my final opinion.

10. Reviewer's personal impressions of the applicant and other information not mentioned in the preceding paragraphs.

I have known Kirill from our many years of working together in the Department of Solid State Physics and Microelectronics. What stands out in my idea of his work is depth. Whether it is solid optics or computer skills and software, I have always witnessed a purposeful approach to solving experimental, theoretical or software issues, with care and without haste to reach the intended goal. The versatility of his knowledge and skills, as well as the ability to work with different teams, are striking, as is evident from the topics of the published articles. This allowed him to lead one national project with the NRF and participate in 22 national and international projects. Within these projects, several short-term specializations were implemented in research units in France and Germany. It is also positive that three of the attached articles were completed in collaboration with undergraduate and doctoral students.

10. Reasoned and clearly worded conclusion.

Relying on the facts, considerations and conclusions outlined above, I strongly suggest that the Faculty Council of the Faculty of Physics, Sofia University, elect Assistant Professor Dr. Kiril Mladenov Kirilov for Associate Professor in Scientific Field 4.1 “Physical Sciences” (Electrical, Magnetic and Optical Properties of Condensed Matter).

Date: 9/02/2020 Reviewer:

/Prof. V. Strashilov/