OPINION

on a dissertation for the award of the scientific degree **"Doctor (PhD)"**

Author of the dissertation: Petar Todorov Kolev, PhD student at the Institute of Optical Materials and Technologies "Acad. Yordan Malinovski", Bulgarian Academy of Sciences

Title of the dissertation: "Sensors Based on Spectral Polarimetric Detection"

Professional field: 4.1 Physical Sciences

Doctoral programme: "Electrical, Magnetic and Optical Properties of Condensed Matter"

Scientific supervisor: Prof. Dr. Georgi Dyankov

Reviewer: Prof. DSc Vesselin Donchev, Faculty of Physics, Sofia University "St. Kliment Ohridski", appointed as a member of the scientific jury by order of the Director of IOMT–BAS RD 15959 / 16.12.2025

1. Information about the PhD Candidate

Petar Todorov Kolev obtained his Bachelor's degree in 2009 from the Technical University of Sofia, Faculty of Power Engineering and Mechanical Engineering, Department of Hydro-aerodynamics and Hydraulic Machines, speciality "Hydraulic and Pneumatic Engineering". In 2015, he completed his Master's degree at the same institution. He worked for two years as a design engineer of hydraulic machines at Hydropneumotechnika AD, Kazanlak, and for another three years was engaged in construction and renovation activities.

In 2022, he was appointed at the Institute of Optical Materials and Technologies (IOMT) as an electronics engineer. From 2024 to the present, he has been working as an assistant at the same institute, carrying out research activities in the field of optics. He prepared a dissertation and, in December 2025, submitted an application to the Scientific Council of IOMT to initiate the defence procedure.

2. General Description of the Dissertation

The dissertation consists of 106 pages and includes an introduction with motivation, aims and objectives, a general part (literature review), two chapters of a specialised part, conclusions, main contributions, and 135 references. Lists of abbreviations, figures, measurement units, publications on the topic with citations, and participation in scientific forums are also provided.

The dissertation is devoted to the method of **Channel Polarimetry Method (CPM)** and its application in two types of sensors: a) sensors based on Surface Plasmon Resonance, and b) sensors based on magneto-optical effects.

The topic is relevant, as CPM is still not widely used in optical sensing and has significant potential for applications in low-cost, compact sensors, point-of-care biosensors, and large-scale industrial diagnostics. The relevance of the addressed problems is well justified in the dissertation. The extensive literature review demonstrates that the PhD candidate is well acquainted with the investigated problems from both theoretical and practical perspectives.

The aim of the research is the **experimental development of CPM and the investigation of its applicability and efficiency in different types of sensors**. In accordance with this aim, two specific tasks are formulated: 1) Design and fabrication of a channel spectral polarimeter, and

2) Experimental demonstration of the advantages of CPM. Appropriate methods have been selected for their implementation.

3. Main Scientific Results, Contributions and Significance

In the dissertation, an original method for **channel spectral polarimetry**, based on phase encoding of polarisation information, has been developed and experimentally implemented, enabling simultaneous and precise extraction of the Stokes parameters. New configurations of phase retarders in two thickness ratio variants have been proposed and optimised, and their performance has been compared. It has been experimentally demonstrated that **phase-based measurements**, compared to amplitude-based ones, provide significantly higher signal-to-noise ratio, lower detection limit, and better statistical reliability in biosensors, gas and model systems over a wide dynamic range of refractive index. For the first time, the method of channel polarimetry has been applied to **magneto-optical sensors based on the Faraday effect**, allowing direct measurement of the induced phase shift and significantly improving the temperature stability of the measurements.

The presented results are original and reliable.

I agree with the claimed contributions of the dissertation. The contributions have an applied-scientific character, as they are related to solving specific problems and to practical applications.

4. Assessment of Publications and Personal Contribution

In the presented documents, the PhD candidate has included 4 publications, 3 of which are in journals with an impact factor. The publication in *Optics Communications* has been cited 9 times, and 2 other publications have been cited once each. The PhD candidate has participated actively in scientific forums with one oral and 8 poster presentations.

There is no doubt that the candidate has made a substantial contribution to the preparation of the presented publications, as confirmed also by the certificates provided by the corresponding authors.

It is noteworthy that in Scopus, there are a total of 8 publications with the participation of Petar Kolev, two of which are new from 2025. The total number of citations is 19, and the h-index is 2.

5. Critical Remarks and Recommendations

My main critical remark is that the dissertation text has, to a large extent, an engineering and technical character, at the expense of more detailed explanations of the quantities and processes from a physical point of view. For example, no definition is given of the widely used Stokes parameters, and it is assumed that the reader is familiar with them. Also, a strict definition of the concept of "channel" in the method of channel polarimetry is not provided.

Other, less significant remarks are:
a) lack of explanation of some abbreviations at their first occurrence (e.g., SOP – state of polarisation);
b) use of the term "diffraction order" in a non-standard way;
c) chemical formulas without subscripts.

6. Questions for the PhD Candidate

1. How is the autocorrelation function obtained, and what is its physical meaning?

2. In the study of the magneto-optical effect, the material BSO is used, which has its own optical activity with dispersion. This optical activity is superimposed on the magnetically induced optical activity, complicating the analysis. Would it not have been better to choose a material without intrinsic optical activity?

7. Conclusion

Despite the remarks made, I believe that the stated objectives have been successfully achieved and the tasks fulfilled, and that the submitted dissertation contains valuable contributions. Significant experimental experience has been accumulated in the development of precise optical schemes. The design and implementation of a channel spectral polarimeter has been successfully achieved thanks to precisely fabricated phase retarders. Spectral measurements of phase variations in polarisation-sensitive sensors have confirmed the effectiveness of CPM, outlining promising future directions for development.

Based on all the above, I vote "YES" and recommend to the esteemed scientific jury to award the educational and scientific degree of "Doctor" in the professional field of 4.1 Physical Sciences, speciality "Electrical, Magnetic, and Optical Properties of Condensed Matter" to Petar Todorov Kolev.

Date: 11.02.2026

Reviewer:

Prof. DSc Vesselin Donchev