OPINION

on the competition for the academic position of "Associate Professor"

in the group "Optical Sensors", Central Laboratory of Applied Physics at the Bulgarian Academy of Sciences

in professional field 4.1 "Physical Sciences", scientific specialty "Condensed Matter Physics" (Development of technologies and devices for application in sensorics and photonics),

according to the announcement in the State Gazette No. 55 of 08.07.2025

Candidate: Assistant Professor Dr. Hristo Todorov Kisov (CLAP-BAS)

Member of the Scientific Jury: Prof. Dr. Lilyana Petrova Kolaklieva (CLAP-BAS)

1. General characteristics of the submitted materials.

Assistant Professor Dr. Hristo Todorov Kisov is the only candidate in the competition. The candidate has submitted all required documents, according to the Regulations on the conditions and procedure for acquiring scientific degrees and for occupying academic positions of the Central Laboratory of Applied Physics - BAS. Asst. Prof. Dr. Hristo Kisov meets the conditions for participation in the competition. In 1996, he graduated from the Faculty of Physics of the Plovdiv University "Paisiy Hilendarski", specialization "Laser Equipment and Technologies" as an engineer-physicist (diploma for completed higher education, equivalent to a "master's degree"). In 2012, he obtained the educational and scientific degree "doctor" at the Technical University of Sofia – branch Plovdiv with a dissertation on the topic "Development of solid-state quantum generators based on Neodymium-YAG media with uncompetitive simultaneous generation of a pair of lines and frequencies in the interval 1 - 1.4 microns". Since 2017, he has been an Assistant Professor at the Institute of Optical Materials and Technologies "Acad. Y. Malinovski" - BAS. He joined the CLAP as an Assistant Professor in 2021 and has been working there as such until now, thus fulfilling the required internship for the academic position of "Associate Professor".

Assistant Professor Dr. Hr. Kisov is a co-author in 28 publications. All publications have an impact factor and SJR. He participated in the competition with 28 publications, of which 9 are presented as equivalent to a habilitation thesis. In 5 of them, Assistant Professor Dr. Hr. Kisov is the first author. Of the publications presented as habilitation thesis, 3 fall into the quartile Q1, two publications fall into the quartile Q2, 2 – in the Q3 and two in refereed journals with SJR. Outside the habilitation reference, 19 publications are presented, of which in Q1 – 5, Q2- 1, Q3 – 1, Q4 – 1, 10 are with SJR and 1 falls into the category of “other refereed”. Assistant Professor Dr. Hr. Kisov is a co-author in two utility models and one submitted application for invention.

To date, 39 citations of scientific publications by Dr. Kisov have been noted, of which 18 citations of publications presented as habilitation thesis and 21 publications outside the habilitation thesis. The total Hirsch index (h-factor) of Dr. Kisov's overall scientific output is 4. Dr. Kisov has participated in 6 national and international scientific forums. His scientific activity is supported by participation in one national research project and 5 external to the unit (base organization IOMT), of which one is international. During the period 2012 - 2013, Dr. Kisov was a part-time assistant

at the University of Plovdiv and the Technical University, Plovdiv branch and supervised of 6 Masters' and 3 Bachelor's degrees from these universities. Currently, Dr. Kisov is a supervisor of a Master's student at the University of Plovdiv.

The analysis of the materials submitted in the competition shows that Dr. H. Kisov has the necessary number of points to occupy the academic position of "Associate Professor", as defined in the Regulations on the conditions and procedure for acquiring scientific degrees and occupying scientific positions in the CLAP. In some categories, the number of points exceeds the minimum requirements: Group A – 50 points out of a minimum of 50 points, Group B – 165 points out of a minimum of 100 points, Group G – 343 points out of a minimum of 220 points, Group D – 78 points out of a minimum of 60 points, Group E – 140 points, with no points required for this indicator. The candidate participated in the competition with a total of **776** points out of a required **430** points.

2. General characteristics of the candidate's scientific research activity.

2.1. Main scientific contributions presented in the habilitation thesis.

The contributions of the candidate, presented in the publications, equivalent to a habilitation thesis, can be summarized in two main areas as follows:

1. Development and research of laser media for cavityless lasers (random lasers).

A solid-state composite laser medium was developed, consisting of epoxy resin with a hardener, in which the organic dyes Rhodamine 6G and Rhodamine are incorporated, which demonstrates a fluorescence spectral region with a width of over 100 nm. The structure of the created material was analyzed by scanning electron microscopy, atomic force microscopy, transmission electron microscopy, and electron diffraction. It was found that the medium is a self-nanostructured amorphous material, resulting in high internal light scattering, eliminating the need for additional scattering particles. A threshold excitation energy of 1.6 mJ was determined, at which the amplified spontaneous emission passes into laser generation with a sharply narrowed spectrum. Multimode generation with distinct peaks was observed, and the refractive index, measured by ellipsometry, was approximately 1.56 at a wavelength of 597 nm. Four-wave frequency mixing was achieved, realized with a single nanosecond pulse. This mixing was observed for the first time in a similar material and is due to the high nonlinearity and amplification in the active medium. By increasing the excitation energy above the threshold, peaks with a spectral range of 0.2–0.3 nm were generated, which confirms the presence of coherent feedback. The calculated conversion efficiency is about 8%, with the dependence on the excitation energy remaining almost linear even at significantly above-threshold values. The influence of silver nanowires on the threshold energy and radiation intensity has also been studied. Laser radiation above 700 nm has been achieved, and the presence of nanowires contributes to additional positive feedback. By using gold nanowires with a high concentration, coherent radiation has been achieved at low excitation energy.

These achievements demonstrate the potential of composite media for application in modern quantum electronics and photonics.

2. Development and optimization of laser technologies for the deposition of nanoscale layers of biological materials in a vacuum environment.

The deposition of nanoscale layers of biological materials in a vacuum environment is based on the established MAPLE (Matrix-Assisted Pulsed Laser Evaporation) technology, which is an effective method for the transport and deposition of delicate, bioactive molecules. For this purpose, the first vacuum system at the Bulgarian Academy of Sciences was created, working with assisted pulsed laser evaporation on diffraction gratings, allowing freezing of samples, which is an important stage for preserving the bioactivity of biological substances during deposition. Direct immobilization of hemoglobin (Hb) was achieved through the MAPLE technology, and it was proven that the functional groups of the deposited layer retain their activity. This allows for the detection of glucose by surface plasmon resonance (SPR). A significant contribution is the development of a modified version of the technology, in which a synergistic effect between a long-period lattice fiber structure (LPG) and directly immobilized Hb was established, allowing the creation of a highly efficient glucose biosensor.

Through theoretical and experimental analysis of structures including cholesteric layers (CLC) and a metal grating for SPR, it has been shown that the simultaneous excitation of two SPR modes is possible when using a diffraction grating and a CLC medium, which indicates that such a structure is applicable to sensor technologies.

These achievements are of essential importance for researchers working with metalloproteins.

2.2. Scientific contributions presented in works outside the habilitation work.

The scientific contributions outside the habilitation work of Dr. H. Kissov cover three main areas: development of laser technologies for the deposition of biological layers in vacuum; study of the penetration of laser radiation into opaque tissues (including dental); as well as analysis of the dispersed composition of biopolymer emulsions.

The research is focused on preserving the bioactivity of sensitive molecules such as hemoglobin (Hb) and myoglobin (Mb), as well as the development of highly sensitive biosensors and optical diagnostic platforms. Through SPR analysis upon interaction with CO, CO_2 and NO, it has been proven that Hb and Mb, directly immobilized onto gold-plated diffraction gratings, retain their functionality while preserving the active groups and good adhesion to the substrate. To avoid thermal deformation of proteins, the deposition technology was optimized by the wavelength of the laser radiation, the pulse energy and its density, and the pulse repetition rate. A sample preparation technology was also developed, which further contributes to preserving bioactivity during the deposition process.

These studies demonstrate the wide range of applications of MAPLE technology – from biosensors and cell analysis to medical diagnostics and optical sensors. The achieved results confirm the method as a reliable tool for direct immobilization of bioactive molecules

3. Conclusion.

The scientific contributions of Dr. Kisov in the presented research are clearly outlined.

Based on the materials provided to me, I am convinced that Assist. Prof. Dr. Hr. Kisov is a specialist with in-depth expertise in the MAPLE technology for the transport and deposition of bioactive molecules. He possesses substantial experience in studying the interaction of laser radiation with biological objects and in analyzing the dispersion composition of biopolymer emulsions.

Furthermore, the materials show that he meets all the requirements of the Law on the Occupancy of Academic Positions, the Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and for Occupying Academic Positions at the Bulgarian Academy of Sciences and the Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and for Occupying Academic Positions of the Central Laboratory of Applied Physics.

On this basis, I strongly recommend to the esteemed Scientific Jury, Assist. Prof. Dr. Hristo Todorov Kisov to be elected as "Associate Professor" in the professional field of "Physical Sciences" at the Central Laboratory of Applied Physics - BAS.

20.10.2025 Signature:

Plovdiv /Prof. Dr. L. Kolaklieva/