OPINION

by **Assoc. Prof. Daniela Bogdanova Karashanova**, PhD
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on the competition for holding the academic position "Associate Professor" announced at IOMT-BAS, department "Optical Metrology and Holography"
in professional field 4.1. Physical sciences, scientific field " Physics of Wave Processes "

1. General performance

By order No.RD-15-718 of December 01, 2022 and No.RD-15-729 of December 07, 2022 of the Director of IOMT, I have been appointed as a member of the scientific jury of a competition for the academic position of "associate professor" in professional field 4.1 Physical sciences, scientific field "Physics of wave processes".

The only candidate in this competition, announced in the State Gazette, issue 79 of October 04, 2022 is **Nataliya Dimitrova Berberova-Buhova, assistant professor, Ph.D.**

2. Assessment of the scientific and research accomplishments of the candidate

The results of Dr. Nataliya Berberova-Buhova's research activities have been developed within 20 research projects, 5 of which she herself is the head of, and she is a participant in 15 projects with other team leaders.

Dr. Berberova-Buhova is a co-author in 56 scientific publications, 41 of which are in impact-factor and impact-rank journals, and 13 are the basis of her dissertation work , defended in 2016. The independent citations that the publications received in total are 102. Dr. Berberova-Buhova has presented the results of her research at 65 scientific forums.

Dr. Berberova-Buhova has selected 27 of her publications for her participation in the current competition for the academic position of "associate professor", announced at IOMT-BAS. All of them were published in journals with impact factor or impact rank and distributed in quartiles as follows: 6 Q2, 2 Q3, 3 Q4, 16 SJR. Among the journals, the renowned ones in the field of optics, photophysics and photonics are notable: *Journal of Photochemistry and Photobiology A: Chemistry* and *Optical Materials* . In 5 of the publications, the candidate is the first author. Her Hirsch index (h - index) is currently 5.

7 of the presented publications are the core of a habilitation thesis, and the remaining 20 are presented outside of it. Citations from other authors in the Scopus and Web databases included in the competition of Science are 31.

These quantitative indicators provide the necessary points, corresponding to the minimum national requirements, reflected in the Republican Regulations for the implementation of the RASRB, as well as in the Regulations of the BAS and the IOMT-BAS and they are as follow:

According to criterion A (min. 50 points) - 50 points
According to criterion B (min. 100 points) - 110 points
According to criterion Г (min. 220 points) - 236 points
According to criterion Д (min. 60 points) - 62 points

3. Research activity and contributions of the candidate

In general, Dr. Natalia Berberova-Buhova's research activity is devoted to the problems of polarization holography. In part of the research, reflected in the publications - equivalent to a habilitation thesis (A1 - A7), the possibility of improving the parameters of polarization holographic recording in one of the main media for this type of information recording, such as azopolymers, was investigated. The contributions in these studies are related to establishing the

conditions for achieving the maximum optical response (the maximum value of the photoinduced linear birefringence Δn_{max} and the response time) of the materials, which was achieved through the detailed study of multiple factors such as type, size, shape and concentration of nanoparticles with which the polymer films are doped – Au, ZnO, TiO_2, α-FeOOH (goethite), bioactive complexes based on copper and nickel ions, and also the solvent type of the PAZO polymer in the deposition of the polarization recording films. A hypothesis was formulated about the dependence of birefringence on the size of the doping nanoparticles, which influence the increase of Δn for these nanocomposites to a greater extent with the free volume created around them than with the scattering of light. The spectral behavior of the birefringence was established and the optimal recording wavelength was found experimentally. The dependence of the diffraction efficiency of the recorded diffraction gratings with a period in the range from 0.86 to 2.51 μm on the height of the formed relief was evaluated. The highest diffraction efficiency of ±1 order (total for both orders of 53%) was achieved for the nanocomposite with 10% concentration of NPs at a recording angle ($2\theta = 20°$)

Publications outside the habilitation thesis are divided into 3 thematic areas:

1. Reversible polarization holographic recording and analysis of the resulting diffraction grating parameters – covers 4 publications (B1-B4)
2. Dynamic speckle analysis and its application for non-destructive control in fast-changing processes (drying of polymer thin films, etc.). Numerical methods for image processing – 10 publications (B5-B14)
3. Modeling the optical response of surface-relief diffraction gratings by varying their parameters. Modeling optical constants - 6 publications (B15-B20)

In the research on the **first topic**, the main contributions are the establishment of the scientific fact that the maximum value of birefringence in azopolymer PAZO films does not depend on the thickness of the layer and is of the order of 0.07 for all studied samples, as well as that for samples thicker than 500 nm, the response time significantly increases compared to those with a thickness in the range of 50-500; investigation of optical and thermal reversibility of photoinduced birefringence in azopolymers; achieving the highest value of diffraction efficiency at left and right circular polarizations in polarization holographic gratings recorded at four different combinations of recording beam polarizations; establishing the dependences of azimuth rotation and output ellipticity on input ellipticity for pure and nanocomposite azopolymer layers.

Research on the **second topic** has led to the following significant results and contributions: the successful application of the dynamic speckle analysis method for tracking rapidly changing processes (in this case, tracking the drying of a PAZO polymer with solvent water and the effect of a cosmetic product on human skin); the development of algorithms for improving the visualization of the activity map (increasing the contrast) through statistical processing of the speckle images; analyzing the sensitivity of the dynamic speckle method by processing simulated and experimental 8-bit coded speckle images; application of a controllable spatial time-varying speckle image generation technique for testing algorithms in dynamic speckle metrology using a phase-space-light modulator; developing models for digital image processing to clean up noise superimposed on images.

Contributions under the **third topic** are related to a proposed model for evaluating the diffraction efficiency of a "hybrid" diffraction grating composed of a relief grating on the surface of a bulk polarization grating under varying spatial frequency, height and relief shape of the surface grating; developing a model for evaluating the optical response of an azopolymeric PAZO layer doped with TiO_2 spherical particles with an average radius of 10 to 80 nm by determining the elements of the phase matrix (the scattering matrix); Determination

of the optical response and complex refractive index in a wide spectral range (320 – 700 nm) for nanocomposite media containing the azopolymer PAZO and gold nanoparticles and with three different nanoparticle sizes and three different filling factors.

In conclusion, I would like to note that the presented and above-mentioned main results and contributions of Dr. Berberova-Buhova's scientific research are substantial and original. They are in an area that is of great interest not only from a fundamental, but also of an applied point of view, and they tangent to an important direction in modern European and world science - Information and communication technologies.

Although it is not explicitly emphasized in the materials submitted for the competition, I believe that the role of Dr. Berberova-Buhova in the above-mentioned studies is significant and leading in some of them.

Finally, I would like to point out that Dr. Berberova-Buhova has considerable experience as a teacher, and since 2014 she has been the secretary of nine editions of the IOMT annual Spring Seminars for PhD students and young scientists “Interdisciplinary Chemistry”, organized by IOMT since 2014. Although I do not find this information noted in the submitted documents, I believe that this experience can only benefit her in her future career development as an Associate Professor.

CONCLUSION

Documents and materials presented by the candidate in the competition, Chief Assistant Professor Natalia Dimitrova Berberova-Buhova, PhD, fully meet the requirements of the Development of Academic Staff in the Republic of Bulgaria Act (DASRB), the Rules for the Application of the Development of Academic Staff in the Republic of Bulgaria Act, the Rules of BAS and with the Rules set at the IOMT-BAS.

The contributions described in the publications correspond to the topic of the announced competition for "Associate Professor" in the scientific specialty "Physics of wave processes", being substantial and original. That is why I **give a positive assessment** to the works and activities presented in the competition and I recommend the honorable members of the Scientific Jury to prepare a report with a proposal to the Scientific Council of IOMT-BAS, **Dr. Natalia Dimitrova Berberova-Buhova** to be elected as an Associate Professor at IOMT-BAS, in professional field 4.1. Physical Sciences (Physics of Wave Processes).

January 30, 2023

Opinion prepared by: .....

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