

REVIEW

by competition for the academic position "Associate Professor"
Professional field: 4.1. Physical sciences
according to an announcement in the Newspaper of State, no. 79/04.10.2022
for the needs of IOMT - BAS,
with only candidate Dr. Nataliya Dimitrova Berberova-Buhova

written by: Prof. DSc Vera Marinova, IOMT- BAS

Dr. Nataliya Berberova-Buhova is the only candidate in the competition for the academic position "Associate Professor", announced in the Newspaper of State, issue 79 from 04.10.2022 for the needs of IOMT - BAS.

1. General characteristics of the presented materials.

In the competition for the academic position " Assistant Professor" Dr. Nataliya Berberova-Buhova participated with a total of 27 scientific publications in refereed international publications, including:

- 7 publications, published in journals with an impact factor and SJR (referring to indicator B4) are presented for "Habilitation work",
- 20 publications in impact-factor/impact-rank journals (referring to indicator Г).

The habilitation thesis (indicator B4) includes 7 publications, of which 4 in category Q2 and 3 in SJR. The publications were published in the period 2013 - 2021 and are related to the research of optical properties of photopolymer materials as media for polarization holographic recording and their optimization through the addition of nanoparticles of different size and concentrations. In one of them the candidate is the first author.

The publications outside the habilitation work are a total of 20 (referring to indicator Г), all of them published in refereed and indexed in the world-known databases of Web of Science and Scopus), including 2 publications in the category Q2, 2 publications in category Q3, 3 publications in category Q4 and 13 in SJR. In four of these total of 20 scientific works, the candidate is the first author.

There are 62 citations noted under the competition procedure.

Dissertation for ONS "Doctor" on a topic "Coherent Optical Metrology: Methods and Implementation with a Spatial Light Modulator" is written and defended on the basis of 13 publications in journals with impact factor/impact rank and SJR, as well as participations in international conferences.

Until now, Dr. Nataliya Berberova-Buhova is a co-author in a total of 56 scientific articles, 41 of which were published in journals with impact factor and impact rank, 102 citations were noticed, h -factor is 5.

In accordance with the requirements for holding the academic position "Associate Professor", laid down in the Law on the Attainment of the Academic Staff in the Republic of

Bulgaria (ZRASRB) and the rules for the conditions and procedures for acquiring scientific degrees and holding academic positions in IOMT-BAS, candidate Dr. Natalia Berberova-Buhova presented:

to indicator A - 50 points (from a minimum of 50 points)

to indicator B - 110 points (from a minimum of 100 points)

to a group of indicators Γ - 236 points (from a minimum of 220 points)

Γ 7. 20 scientific publications in publications referenced in Web of Science and Scopus, outside the habilitation thesis - 2 3 6 points

to indicator Δ - 62 points (from a minimum of 60 points)

Citations in scientific publications, monographs, and patents - 6 2 points

The scientific indicators of the candidate Dr. Nataliya Berberova-Buhova fully meet the requirements for occupying the academic position "Associate Professor" laid down in the Regulations of ZRAS RB, ZRAS-BAS and IOMT-BAS.

2. General characteristics of the candidate's scientific, scientific-applied and pedagogical activities

Natalia Berberova-Buhova graduated from the Faculty of Physics of Sofia University "St. Kliment Ohridski" in 2011 , graduating with 2 majors - "Quantum electronics and laser technology" and "Wireless networks and devices". At the end of 2010,s he started working as an assistant physicist at the Central Laboratory for Optical Storage and Processing of Information (currently IOMT), and from 2012 she started a full-time doctorate in the same organization . In 2016 , she successfully defended her doctoral thesis on the topic: "Coherent optical metrology: methods and implementation with spatial light modulator " based on 13 publications with an impact factor and participation at international conferences. Her research is focused on study and optimization of the properties of photoanisotropic materials and their use as media for polarization holographic recording of information. Dr. Nataliya Berberova-Buhova has also experience in the application of dynamic speckle analysis for non-destructive control in fast-changing processes (for example, storage of polymer thin layers, etc.), as well as she is proficient in numerical methods for image processing.

Currently, the candidate has been the leader of 5 successfully completed youth scientific research projects funded by the National Science Fund, as well as participating in 17 scientific research projects.

It should be noted that Dr. Natalia Berberova-Buhova is a co-author of utility model entitled " System for improving polarization parameters of a holographic diffraction optical element, representing a circular polarization splitter ".

3. Basic scientific and/or scientific-applied contributions with an assessment to what extent they are the candidate's personal work.

The main scientific activity of Dr. Natalia Berberova-Bukhova is in the field of polarization holography - research and optimization of the optical properties of photoanisotropic materials, such as azopolymers and azopolymer-based nanocomposites. Azopolymers possess all the desired characteristics of polarization-sensitive materials known to date, such as high values of anisotropy when illuminated with polarized light, high sensitivity and reversibility, therefore they are among the most studied organic materials for polarization holographic recording. These characteristics make them extremely relevant as media for recording reversible polarization gratings with high diffraction efficiency, which is what Dr. Natalia Berberova-Bukhova focused in her academic career. In addition, Dr. Natalia Berberova-Bukhova has many years of experience with speckle analysis for non-destructive control of fast-changing processes, as well as analysis by numerical methods for image processing.

From the presented documents, it is clear that Dr. Berberova-Bukhova is a professional in the above mentioned holographic and speckle analysis techniques and has a significant role for publishing the experimental results obtained so far in the journals, applied to this competition.

Major scientific contributions

The main scientific contributions of Dr. Natalia Berberova-Bukhova can be summarized in the following areas:

A. Improving the optical properties of azopolymer materials for polarization holographic recording by adding nanoparticles – investigation of the effect of their size and concentration

- The influence of the size and concentration of various nanoparticles such as Au, ZnO, TiO₂, bioactive complexes based on copper and nickel ions and goethite (α -FeOOH) nanorods on the optical response and the photoinduced birefringence values in azopolymer and PAZO type.
- An increase of photoinduced birefringence was achieved for all nanocomposite materials obtained from azopolymer PAZO doped with bioactive complexes based on copper and nickel ions.
- It is established that when doping PAZO with TiO₂ and using 2 types of solvents - water and methanol, the layers deposited with solvent methanol have higher values of both the maximum value of the birefringence $\Delta n_{\max}$ and diffraction efficiency, compared to those deposited with solvent water. Here I want to point out that this type of research is important for further experimental activities and has been actively used by other authors.
- The dependence of the diffraction efficiency of the recorded diffraction gratings on the height of the formed relief in PAZO azopolymer doped with goethite nanorods was evaluated, and the highest diffraction efficiency in ± 1 order was achieved with a nanocomposite with 10% concentration and a recording angle of $2\theta = 20^\circ$.

B. Analysis of recorded diffraction grating parameters in reverse polarization holographic recording

- Optical and thermal reversibility of photoinduced birefringence in amorphous, liquid-crystalline polymer and in amorphous polymer PAZO were studied. It has been established that the first two polymers can be completely erased thermally or optically, while PAZO photopolymer can be erased only optically.
- The diffraction efficiency at left and right circular polarizations, recorded at four different combinations on polarizations on the recorded beams were studied
- Dependencies on the rotation on azimuth and ellipticity from the entrance ellipticity for undoped and nanocomposite azopolymeric layers, such as it turned out that small ones concentrations on nanoparticles lead until the appearance of chirality.

C. Study of dynamic speckled analysis and application for non-destructive control at fast-changing processes and methods for image processing

- A method of dynamic speckle analysis was applied to track rapidly changing processes during drying of a PAZO polymer with solvent water and the effect of a cosmetic product on human skin. After recording speckle images and applying appropriate algorithms for processing, activity maps were built for the different stages of the experiment;
- The sensitivity of the dynamic speckle method was analyzed by processing simulated and experimental 8-bit time-correlated coded speckle images. Experiments and numerical simulations were performed by exponentially decaying time correlation function of the intensity fluctuations and Fresnel propagation of a monochromatic wave reflected by a delta-time-correlated phase screen and imaging at different diameters and focal lengths using a three-dimensional concave object covered with a transparent layer and a drop of polymer;
- A technique for generating speckle images with controllable spatial change in time is applied for testing algorithms in dynamic speckle metrology using a phase spatial-light modulator;
- Digital image processing models have been developed to clean up noise superimposed on images.

D. Modeling of the optical response from the surface relief gratings through parameters variation and optical constants modeling

- A model to evaluate the diffraction efficiency of a "hybrid" diffraction grating composed of a relief grating formed on the surface of a bulk polarization grating is proposed. The optical constants of azopolymer PAZO were determined and the spectrum of the complex refractive index of PAZO in the range 320-800 nm was obtained
- A model to evaluate the optical response of an azopolymeric PAZO layer doped with TiO₂ spherical particles by determining the phase matrix elements was developed
- The optical response and complex refractive index in a wide spectral range (320–700 nm) were determined for nanocomposites containing azopolymer PAZO and gold nanoparticles with three different nanoparticle sizes and three different filling factors.

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

The indicated citations to the scientific publications of the candidate participated in the competition according to Web of Science and Scopus are 62.

The total number of citations of all scientific publications of the candidate is 102.

5. Critical notes of the reviewer on the presented works, including the candidate's literary awareness

I have no critical remarks about the candidate.

6. Personal impressions of the reviewer about the candidate

I know Dr. Nataliya Berberova-Buhova since the beginning of her scientific career. Her research and activity are based on her excellent experience on speckle analysis for non-destructive control of fast-changing processes, numerical methods for image processing, as well as processes related to holographic recording in polarization-sensitive polymer media.

Over the years, Dr. Nataliya Berberova-Buhova has been very active and responsible towards her professional commitments, and I believe that she is an extremely valuable member of any scientific team.

Also, Dr. Nataliya Berberova-Buhova is a scholarship holder in the competition "Women in science" 2017 with the topic: "Polarization holographic recording in azopolymer nanocomposites".

7. Reasoned and clearly formulated conclusion.

The documents and scientific works submitted for this competition characterized the candidate Dr. Nataliya Berberova-Buhova as a very well-qualified specialist in the research field.

Here I would also like to note the active participation of Dr. Natalia Berberova-Buhova in several scientific projects, as well as her wellness to introduce holography to schoolchildren and University students, visiting IOMT.

The above data show that the scientific indicators of Dr. Natalia Berberova-Buhova fully satisfy the requirements for holding the academic position "Associate Professor" laid down in the Law on the Regulation of the Academic Staff in the Republic of Bulgaria (ZRASRB) and the regulations on the terms and conditions for acquiring scientific degrees and holding academic positions of IOMT - BAS.

On the basis of the above, I express my full support for the application of Dr. Nataliya Berberova-Buhova and I highly recommend to the honorable Scientific Jury to support and propose to the Scientific Committee of IOMT-BAS Dr. Nataliya Berberova-Buhova to be elected to the academic position "Associate Professor" in the Professional field: 4.1. Physical sciences.

02/01/2023

Reviewer:

/Prof Dr Sc. Vera Marinova /