University of Chemical Technology & Metallurgy
Department of Physics , Thin Films Technology Lab
1756 Sofia, 8 Kl.Ohridsky blvd., Tel. +359 2 81 63 447 , Fax. +359 2 868 54 88
p.petkov@uctm.edu plamen.petkov@abv.bg

REVIEW

on a competition for the academic position of "Associate Professor" in the professional field 4.1. "Physical Sciences" (Physics of Wave Processes) for the needs of the Institute of Optical Materials and Technologies "Acad. Prof. Yordan Malinovsky"(IOMT) of the Bulgarian Academy of Sciences, announced in Official Gazette No. 79 of 04.10. 2022.

The review was prepared by. Prof. Prof. Plamen Kostadinov Petkov, Department of PHYSICS, University of Chemical Technology and Metallurgy, as a member of the scientific jury of the competition according to the Order No. RD 15-718 / 01.12.2022 of the Director of IOMT - BAS.

A single candidate has submitted documents for participation in the announced competition: Assoc. Dr Natalia Dimitrova Berberova-Bukhova, IOMT - BAS.

1. Application data

The documents submitted by the candidate for the competition correspond to the requirements of the Law on Research and Development, the Regulations on the Conditions and Procedure for the Acquisition of Scientific Degrees and the Occupation of Academic Positions at IOMT-BAS.

The candidate has submitted a complete list of his/her scientific publications - 56 pcs. - she has published 56 articles in refereed and non-refereed journals and undoubtedly has an abstract of a thesis.

For participation in the competition, the chief assist. Berberova-Bukhova has submitted a list of 27 titles of scientific publications in refereed Bulgarian and foreign scientific journals and proceedings of scientific forums. The participation of the habilitant in scientific forums is reflected in 18 oral reports and 41 posters, as the presented results are a function of the experiments conducted under contract - 18 international and national projects. 6 other documents (in the form of memos and certificates from an employer, project leader, funding organisation or project sponsor and other relevant evidence) supporting the candidate's

achievements have also been submitted. The attached documents thus enable an objective assessment of the applicant's teaching and research activities.

2. Data about the applicant

Natalia Berberova was born in Sofia in 1985. After completing her primary education she entered the National High School of Precision Engineering and Optics "M.V Lomonosov. She graduated with honours. Since 2005 she is a full-time Bachelor of Engineering Physics at the Faculty of Physics of the Sofia University Kliment Ohridski". At the same faculty in 2011 “she obtained two master degrees: Quantum Electronics and Laser Engineering" and "Wireless Networks and Devices", both defended brilliantly

In 2012, after winning a competition, she continued her studies in the third degree at the Institute of Optical Materials and Technologies at the Bulgarian Academy of Sciences, starting research on "Coherent optical metrology: methods and implementation with spatial light modulator" in the field of "Holography and optical metrology" with the supervisor prof. Elena Stoykova and Assoc. Prof. Petar Sharlandjiev. Having got into an active scientific group, the PhD student quickly entered the scientific issues, gained experience and during the PhD conducted three scientific specializations in South Korea, Taiwan and Finland. This, of course, is one prerequisite for a brilliant dissertation defense in mid-2016 as well. On the other hand, on the basis of her excellent scientometrics and indisputable skills, Dr. Berberova-Bukhova now holds the position of AD" Senior Assistant Professor" in the same scientific group since March of the following year. And in her new capacity, she does not change her rhythm of work, maintaining an average annual rate of publication - 5 scientific articles.

3. General characteristics of the candidate's scientific works and achievements

The scientific interests of chief assist. Berberova-Bukhova are definitely in the field of Solid State Physics (as experimental media) and in the field of Wave Process Physics (as methods and techniques). I definitely support the author's claim by noting two main scientific areas in which she has made significant contributions:

- Polarization holographic recording and parameter analysis of the resulting diffraction gratings in optimized optical media;
- Dynamic speckle analysis and modeling of optical constants and image processing.

The competition submissions fully meet the minimum national requirements, which the candidate exceeds by a factor of about 1.3 (110 points in Group C, 236 points in Group D and 62 points in Group E). The total number of independent citations of these articles is 31 (the total

number of citations noted exceed 100) and the Hirsch index (h-index) is 5. The distribution of scientific articles by quartiles is very good and meets the additional requirements of IOMT - BAS : - Q2 - 6 pcs; - Q3 - 2 pcs; Q4 - 3 pcs and SJR - 16 pcs.

Habilitant's experimental results are definitely due to her participation in scientific research projects funded by different organizations - Ministry of Education and Science - FNI, BAS, EC, etc., in 13 of them she is a participant, and in 5 projects she is a supervisor. In the implementation of the projects the candidate has shown herself as a talented experimenter, organizer and undoubtedly a leading specialist in the lab. "Holographic Metrology, and this judgment is the result of the author's position in the reviewed papers.

The scientific papers presented by the candidate do not repeat those of previous procedures, both for the acquisition of the AD "Associate Professor" and for the acquisition of the ONS "Doctor". This is quite understandable, as this is Dr Berberova-Bukhova's first habilitation, and moreover she does not even use the abstract of her thesis, which has the rank of publication.

Having examined the scientific publications submitted for the competition, I declare with conviction that no plagiarism, signals or allegations of plagiarism have been proven under the statutory procedure.

In conclusion, the scientific production not only meets but also significantly exceeds the minimum national requirements (under Article 2b(2) and (3) of the law) and, accordingly, the additional requirements of the IOMT- BAS for the academic position of Associate Professor in the scientific field and professional field of the competition.

4. A complete analysis of the candidate's scientific and applied achievements contained in the competition materials

The results of the research have a definite scientific and applied character and can be classified as obtaining new data and proving existing hypotheses by new means. The main contributions can be systematized in four main areas as follows:

Optimization of optical properties of materials for polarization holographic recording

- An increase in the photoinduced birefringence Δn in the presence of gold nanoparticles was observed, with a maximum at a size of 20 nm and a concentration of 2a.u. in the azopolymer PAZO (poly[1-4-(3-carboxy-4-hydrophenylazo) benzenesulfonamido]-1,2-ethanediyl, sodium salt];
- The influence of the material response upon the addition of ZnO nanoparticles with sizes of 50 and 100 nm to two amorphous azobenzenes P1 and P1-2 has been determined, with an optimum achieved at 50 nm size;

- A hypothesis for the dependence of birefringence on the size and type of incorporated nanoparticles was formulated. The increase in Δn for these nanocomposites is due more to the free volume effect introduced by the additional nanoparticles than to the scattering of light by them;
- Results of the increase in photoinduced birefringence for all nanocomposites derived from PAZO azopolymer doped with bioactive complexes based on copper and nickel ions were obtained for the first time, and the optimal conditions were determined;
- Two distinct birefringence peaks were found for 6 PAZO azopolymers doped with goethite nanorods of approximately 15 x 150 nm (1:10) and eight different concentrations ranging from 0 to 15%. The peaks are for nanoparticle concentrations of 1% and 10%. It was hypothesized that this unusual dependence was due to the two characteristic sizes of the nanorods;
- The optical parameters of two groups of layers containing PAZO and different concentrations of TiO2 nanoparticles were compared - in solvent water and methanol. It was found that the layers deposited with methanol solvent had higher values of both Δnmax and diffraction efficiency;
- The spectral behavior of birefringence at three wavelengths (355 nm, 444 nm, 514 nm - from the absorption peak for the PAZO azopolymer to the end of the absorption band) in thin films of pure azopolymer and azopolymer nanocomposites with different nanoparticle concentrations was determined;
- 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 for samples of PAZO azopolymer doped with goethite nanorods, and the spatial frequencies of the gratings were obtained by varying the angle between the recording laser beams (2θ = 10°, 20° or 30°). The highest diffraction efficiency in ±1 order of magnitude (total for both orders of 53%) was achieved for the nanocomposite with 10% concentration at the recording angle (2θ = 20°).

Parameter analysis of reversible polarization holographic diffraction gratings

- The maximum value of birefringence in azo-polymer PAZO layers was shown to be independent of the layer thickness (50 nm - 2500 nm) and was of the order of 0.07 for all samples studied. For samples thicker than 500 nm, the response time increases significantly due to the attenuating intensity of the pump laser in depth;

- Repeated recording and erasure kinetics of birefringence in different azopolymer layers were obtained to investigate the optical and thermal reversibility of photoinduced birefringence in azopolymers. The studied polymers are polymer P1 and copolymer P1-2, which are amorphous, liquid-crystalline polymer P2 and amorphous polymer PAZO. It is found that P1, P1-2 and P2 can be repeatedly erased both thermally and optically, while the PAZO polymer can only be erased optically;
- The highest value of diffraction efficiency was achieved for left and right circular polarizations in polarization holographic gratings recorded at four different combinations of the polarizations of the recording beams;
- The dependences of azimuth rotation and output ellipticity on input ellipticity have been established for pure and nanocomposite azopolymer layers

Dynamic speckle analysis. Numerical methods for image processing;

- The dynamic speckle analysis method has been successfully applied to tracking rapidly changing processes, in this case tracking the drying of a PAZO polymer with solvent water and the effects of a cosmetic product on human skin;
- Algorithms have been developed to improve the visualization of the activity map by statistical processing of the speckle images: estimates of a normalized temporal correlation function and a normalized temporal structure function;
- Analysis of the sensitivity of the dynamic speckle method by processing simulated and experimental 8-bit encoded speckle images correlated in time by comparing small regions of activity even at quite close temporal correlation radii in the region of interest and surrounding background. Numerical simulation and experiment were performed by exponentially decaying the temporal correlation function of the intensity fluctuations and Fresnel propagation of a monochromatic wave reflected from a delta-correlated time-phase screen and imaging at different lens diameters and focal lengths of the optical sensor lens;
- Digital image processing models have been developed to clean the noise superimposed in the images. Numerical simulation has been carried out for filtering two-dimensional images and various wavelet techniques for de-noising and smoothing the data.

Modeling the optical response of surface-relief diffraction gratings by varying their parameters. Modeling of optical constants.

- A model has been developed to evaluate the diffraction efficiency of a "hybrid" diffraction grating composed of a relief grating on the surface of a bulk polarization grating while varying the spatial frequency, height, and shape of the surface grating relief;

- A model has been developed to evaluate the optical response of an azo-polymer PAZO layer doped with TiO2 spherical particles with an average radius from 10 to 80 nm by determining the phase matrix elements;
- The optical response and complex refractive index in a wide spectral range (320 - 700 nm) for nanocomposite media containing azopolymer PAZO and gold nanoparticles and with three different nanoparticle sizes and three different fill factors were determined.

5. Critical remarks and recommendations

I have no critical comments regarding the candidate's research. As far as recommendations are concerned, I would suggest two - to be more active in publishing (in relation to the upcoming changes in the national law) and not to lose enthusiasm for funding future research.

6. Personal impressions of the candidate

My first contacts with Dr. Berberova date back to time when she was a PhD student at IOMT - BAS. Our next meetings were at conferences, during joint experiments and evaluation of experimental results. As NATO ASI Director, I was pleased to give Dr. Buhova the opportunity to present the group's experimental achievements to a broad scientific audience, and Dr. Buhova was recognized by an international jury for these contributions. In short, my personal impressions of the person and scientist Natalia Berberova-Bukhova are definitely excellent.

7. Conclusion on the application

Having read the materials and scientific works submitted in the competition and on the basis of the analysis of their significance and scientific and applied contributions contained therein, I confirm that the scientific achievements meet the requirements of the Law on Research and Development, the Regulations for its application and the relevant Regulations of the IOMT-BAS for the academic position of Associate Professor in the scientific field and professional field of the competition. In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been found in the scientific works submitted for the competition.

I give my positive assessment of the application

8. GENERAL CONCLUSION

On the basis of the above, I recommend that the scientific jury propose to the competent authority for the selection of the Institute of Optical Materials and Technologies 'Acad. Y. Dr Natalia Dimitrova Berberova-Bukhova to the academic position of Associate Professor in the professional field 4.1 Physical Sciences (Physics of Wave Processes).

Sofia, 12.01.2022.

(Prof. Dr. Eng. Plamen Petkov)