REVIEW

on the competition for holding the academic position "Professor" in the professional field 4.1. "Physical Sciences", specialty "Physics of Wave Processes" at the Institute of Optical Materials and Technologies - BAN, announced in GN No. 12 / 11.02.2020.

Candidate: Assoc. Prof. Dr. Dimana Ilieva NAZAROVA.
Reviewer: Prof. Dr. Eng. Plamen Kostadinov PETKOV, Department of Physics, University of Chemical Technology and Metallurgy

1. General concepts and brief biographical data of the candidate.

The competition for the academic position "Professor" was announced in GN No. 12 / 11.02.2020 for the needs of the Institute of Optical Materials and Technologies at the Bulgarian Academy of Sciences. The single candidate in the competition is Assoc. Prof. Dr. Dimana Ilieva Nazarova from the same institute. From the submitted documents it is evident that the candidate has the necessary qualification for participation in a competition for the academic position "Professor", according to National rules and Art. 25 of the Regulations on development of the academic staff of IOMT - BAS.

Dimana Nazarova was born on May 7, 1969 in the town of Haskovo. In 1987 he graduated with honors from the High School of Natural Sciences and Mathematics, Haskovo and in the same year entered the Sofia University "Kliment Ohridski". In 1992 she successfully graduated with a master's degree in Physics, specialty - Applied Physics. In 2000 she successfully obtained a master's degree from the University of National and World Economy - majoring in Finance. Since the winter of 2003, the professional path of Assoc. Prof. Nazarova is inextricably linked with the Bulgarian Academy of Sciences - she started working as a physicist at CLOSOI - BAS, and the following year, after successfully passing a competition she started as PhD student. Three years later she defended her dissertation on "Optical resonances in diffraction and scattering structures." This is the beginning of her growth in the scientific hierarchy - 2006. - research associate II rang., 2009 - research associate I rang and since July 2011 she is an associate professor at IOMT-BAS.

During the years spent at the Academy, Assoc. Prof. Nazarova is among the scientific elite of the institute, and is currently the head of "Optical Metrology and Holography", a member of the National Assembly and chairman of the General Assembly of IOMT - BAS.

The scientific activity of Assoc. Prof. Nazarova, which will be analyzed below, is in the field of Solid State Physics and in particular Physics of the wave process - optical recording of information.

2. Scientific work and activities presented by the candidate.

Assoc. Prof. Nazarova presents significant volume of scientific production, well popularized in international and national scientific journals. According to the requirements of National rules, only scientific papers are presented, which have not participated in the competitions of the candidate for the degree "PhD" and position "Associate Professor". The scientific indicators of the production are as follow:

a) Scientific publications in specialized journals with IF or SJR - 21 ;
b) Reports at national and international scientific forums - 86
- oral presentations - 22;

- poster presentations - 64;

c) Research projects participation - 5;

d) Participation in research projects - 13, including 3 international projects;

e) Training of graduates, postgraduates and doctoral students - 12 ;

The number of independent citations is 132, a number relatively relevant for an applied scientist.

The scientometric indicators of Assoc. Prof. Nazarova correspond to the recommended indicators for holding the academic position "Professor" according to the Regulations on the Development of Academic Staff of the IOMT-BAS.

3. General characteristics of the research and teaching activity

The scientific activity of Assoc. Prof. Nazarova is entirely in the field of physics of wave processes, the objects of research are mainly solid materials, a fact that facilitates the review. The main part of the experiment concerns the synthesis of new azopolymers based on benzene, as well as composite materials including various nanoparticles - gold, zinc oxide and others. Optical elements are realized by applying polarization recording on the basis of complete optical characterization diffractive.

The pedagogical activity of the candidate is remarkable and should definitely receive a strictly positive assessment. This activity could be summarized as follows:

- Developed lecture courses and curricula for bachelors, masters and doctoral students: "Light-sensitive materials for optical recording: reversible, irreversible and a new type of organic-inorganic composites";
- Training of two PhD students with starting date 2018;
- Training of diploma projects - 5 projects (3 BSc and 2 MSc) all successfully defended.
- Establishment of a training research laboratory - "Holographic record";

From the list of the activities it is clear that the significant teaching activity defines Assoc. Prof. Nazarova as a prominent lecturer.

4. Main scientific and applied contributions of the candidate.

The results of the research are with fundamental-applied character and can be classified as obtaining new data and proving existing hypotheses with new means. The main contributions can be systematized as follows:

- On the basis of ZnO azopolymers low donated with nanoparticles a significant improvement of the photoresponse compared to the pure layers and stability of the photoinduced birefringence in all samples was achieved. An increase of more than 40% in the saturated refractive index (up to _n = 0.08) value was achieved for the amorphous polymer and up to a 20% increase for the liquid crystal polymer. A recording time reduction of about 30% has also been achieved. Regardless of the particle size in the range up to 100 nm, the reaction time is improved. The nanoparticles with a size of 50 nm provide an increase in Δnmax by up to 40%, and those of 100 nm reduce the saturated value of birefringence due to greater scattering;
- An increase in photoinduced birefringence was detected when the layers were donated by 0.03 wt.% of Au nanoparticles in a polymer-based composite [poly [1- [4- (3-carboxy-4-hydroxyphenylazo) benzenesulfonamido] -1.2 -ethanediyl, sodium salt]) - PAZO;
- Diffraction optical elements were recorded by polarization holographic recording in anisotropic hybrid materials. It was found that both the diffraction efficiency and the surface relief height of the recorded polarization gratings in hybrid (PAZO-based organic / inorganic Zn nanoparticles with a size of 50 nm) layers are increased relative to those recorded in the pure azopolymer

layers. A theoretical evaluation of the optical response of a stack of two diffraction gratings with identical one-dimensional periodicity is performed. The first one is the relief structure of the surface; the second - bulk polarization lattice with a good coincidence between the theoretical model and the experimental data regarding the diffraction efficiency and the birefringence of the layers.

- A reversible polarization recording was performed using two different erasing methods - by elevated temperature and by illumination with circle polarized light. It was found that all four tested polymers: P1, P12 and P2, synthesized in IOMT and PAZO (Sigma-Aldrich) are optically reversible, while the thermal reversibility is applicable only for the first three. The maximal values of birefringence are also determined - Δnmax for PAZO - 0.077, and for polymer P12 - 0.065. The temperature dependence of the birefringence in the range 25°C - 100°C and invariance with respect to the thickness from 50 to 2500 nm has been established. The two azopolymers - amorphous P1 and liquid crystalline P2 with the same structures of the main chain and chromophore but different lengths of the chains show difference in the photoinduced birefringence after the recording: in polymer P1 72% is preserved and in polymer P2 - 104% showing that the birefringence stability in the liquid crystalline polymer is significantly higher than in the amorphous one.
- Nanocomposite thin layers of three newly synthesized perylene bis azo-imides in a polyimide matrix were obtained by vacuum evaporation of ODA (4,4'-oxydianiline) and PMDA (pyromellytic dianhydride) as a host polymer matrix and the corresponding pearlin imisals as a "guest" at two different concentrations 5% and 10% wt . The nanocomposite layers improve their photo response at λ = 532 nm compared to the dye layers. The newly synthesized azo and azo-azomethine dyes demonstrate reversible record at two wavelengths 355 nm and 491 nm. The dyes were also tested in a PMMA matrix. The maximum value of the photoinduced birefringence was obtained for Azo-3 dye in a PMMA matrix. In the studies of two azo dyes - Alizarin Yellow and Protractive Pure Yellow in a gelatin matrix an experimental evidence was obtained that the cis isomer of the bisazo dye Protractive Pure Yellow is anisotropic and it is reoriented perpendicular to the direction of polarization light. Photoinduced dichroism is stable one month after irradiation.
- Algorithms for dynamic speckle analysis and their applications for analysis of various activities have been developed. An algorithm has been developed to transform captured 8-bit encoded speckle images into binary images by applying a point threshold. Intensity map filtering was used to improve visualization and quantify activity time scales. A significant narrowing of the probability density functions has been achieved. Filtered maps show improved contrast and allow quantitative description of activity. The activity in the observed sample was statistically described by calculating a temporal structural function. The obtained two-dimensional distributions of this function for different time lags prove the effeciancy of the dynamic speckle analysis for process control in liquid systems.
- The genetic algorithm for determining the optical characteristics of tantalum pentaxide layers deposited on Si (100) substrate by reactive sputtering is applied. The equivalent physical thickness and the equivalent refractive index of the interfacial layer formed between the oxide and the silicon substrate during the deposition process, as well as the thickness of the tantalum pentaxide layer were evaluated. The optical characteristics of Ta2O5 layers deposited on Si substrates and donated with Hf, Al and Ti were obtained by solving the irreverse optical problem using the Genetic Algorithm from the spectrophotometric measurements of the layers in the range 240 - 750 nm.

5. Reflection of the candidate's scientific publications in Bulgarian and foreign literature.

The publications of Assoc. Prof. D. Nazarova represent a significant contribution in the field of physics of condensed matter and the physics of wave processes. They are relevant to both the foundamental science and practice and have already received positive evaluation and international recognition. The results of the candidate research are published in one chapter of a book and 91 scientific publications, 71 of which are in renowned journals with IF and SJR. For information, I will quote some of them - Optical Materials, Optics and Lasers in Engineering, Optics Express, Journal of photochemistry and photobiology.

The 21 publications presented in the competition are result of complex experimental works in the field of physics of optical information recording. In these works, however, her personal contribution to me is indisputable - in 3/4 of the works, she is on first or second place, which shows a leading role in planning and conducting most of the research.

CONCLUSION

The high scientific qualification of Assoc. Prof. Dr. Dimana Nazarova in the field of condensed matter physics and optical recording of information is indisputable to me. She is a fully-build scientist who combines the qualities of an applied researcher and a manager of current research through research projects. The scientific achievements of the candidate verify her very good scientific training in the field of solid state physics and wave process physics. Assoc. Prof. Nazarova has her own subject matter and a clear vision for its development, thus making a significant contribution to the development of research and raising the prestige of the Institute of Optical Materials and Technologies.

In terms of their volume and quality, the scientific and pedagogical activity of the candidate fully satisfies the requirements for achieving the academic position "Professor" according to ZRASRB and the Regulations for growth of the academic staff of IOMT - BAS.

Based on all above I recommend to the Scientific Jury to propose to the scientific council of IOMT - BAS to elect Assoc. Prof. Dr. Dimana Ilieva Nazarova to the academic position "PROFESSOR" in the professional field 4.1. "Physical Sciences" specialty "Wave Processes" for the needs of "Optical Recording of Information" department at IOMT - BAS.

August 11, 2020, Sofia REVIEWER:

/ Prof. Dr. Eng. Pl. PETKOV /