REVIEW

in a competition for the academic position of "Associated Professor" in the professional field 4.1 "Physical Sciences", Scientific specialty "Electrical, magnetic and optical properties of condensed matter", according to the announcement in SG issue no. 57 of 26.06.2020

with a single applicant: Assistant Professor Dr. Ivan Panayotov Bodurov, Plovdiv University "Paisii Hilendarski", Faculty of Physics and Technology

Reviewer: Dr. Tsvetanka Krumova Babeva, Professor at the Institute of Optical Materials and Technologies "Acad. J. Malinovski "(IOMT) - BAS

General description of the presented materials

The materials presented for review by the sole applicant in the competition, Assistant Prof. Dr. Ivan Panayotov Bodurov, fully meet the requirements of the Low of development of academic staff in Republic of Bulgaria (ZRASRB), the Regulations for its implementation and the Regulations for the development of the academic staff of Plovdiv University "Paisii Hilendarski". Dr. Bodurov participated in the competition with 42 scientific publications, 1 book chapter, 3 registered utility models and 2 teaching aids: a guide for laboratory exercises in physics and a short course in electricity, magnetism and optics. 15 of the scientific publications are in journals with impact factor (IF), 15 with impact rank (SJR), 12 are in conference proceedings, and 3 of them are related to physics education. Most of the papers with IF (10 in total) have been published in special issues of *Bulgarian Chemical Communication* from 4 conferences. High-impact journals, such as *IEEE Transactions on Dielectrics and Electrical Insulation* and *Applied Surface Science*, which are classified as Q1, and the second is even Top 1 in the category "*Materials Science, Coatings & Films*" have also been used for publications. As an equivalent of habilitation work, Dr. Bodurov presented 5 publications, thematically related to polyelectrolyte structures and multilayer systems and the use of corona discharge for the modification of thin films. A list of 45 citations is presented, and a reference in *Scopus* (October 2020) shows 54 citations and an *h*- index of 5.

Minimum requirements

The applicant meets the minimum national requirements and in groups Г and D significantly exceeds them:

group A - 50 points (minimum requirements are 50 points)
group B - 100 points (minimum requirements are 100 points)
group Г - 422 points (minimum requirements are 200 points)
group D - 90 points (minimum requirements are 50 points)

All publications of the applicant included in this competition have not been used either in the acquisition of PhD degree or in the awarding of the academic position "Assistant Professor".

General characteristics of the applicant teaching, scientific and applied activities

In 2010 Dr. Bodurov completed a master's degree in condensed matter physics at the University of Plovdiv and started as full-time PhD student at the Institute of Optical Materials and Technologies - BAS, where in 2013 he received the PhD degree within the three-year regular term. At the beginning of 2014 he started working at the Paisii Hilendarski University of Plovdiv as an assistant, and since 2016 he has been working there as an Assistant Professor. Since 2019, he has also occupied the position of Scientific Secretary and was responsible for the organization and administration of research activities. In 2018 he started teaching physics and astronomy at the Professional High School of Electrical Engineering and Electronics in Plovdiv. The attached reference for the teaching activity shows an increasing teaching workload, as in the academic year 2018 - 2019 it was 655 hours, i.e. almost twice the common workload of 360 hours. In addition, Dr. Bodurov has developed 7 studying programs for different courses such as "*Optical Communication Systems*", "*Optical Methods in Experimental Physics*", "*Optical and Spectral Characteristics of Food*", etc., three e-courses and co-authored two teaching aids. Dr. Bodurov was a supervisor of 7 graduates who defended successful Bachelor's degrees in the period 2015 - 2019. All this shows very active teaching activity of the applicant. It is no coincidence that since 2013, for 5 consecutive years, Dr. Bodurov has been invited to participate in organizing committees that conduct national competition in physics "Tournament of Young Physicists", he was a member of the organizing committee of the national student scientific conference on physics and engineering technologies (2018 and 2019) and member of the jury for the best student and PhD student presentations (2016).

A very good impression is made by the fact that despite the busy lecturer activity, the applicant manages to carry out active research, which is highly appreciated. Dr. Bodurov was a member of the working teams of 11 research projects funded by the NSF at the University of Plovdiv (8 projects) and the BNSF-MES (3 projects), participated in a Center of Competence and was a beneficiary of the NP "Young Scientists and postdoctoral fellows". The scientific activity of the candidate could be divided into 3 areas: 1) polyelectrolyte multilayer systems deposited on polymer substrates with potential application for drug delivery; 2) inspection of food by physical methods that do not require the use of chemical reagents; 3) application of corona discharge to modify and / or improve the properties of the studied objects.

Regarding the scientific and applied activity of the candidate, I should note that Dr. Bodurov is one of the inventors of three registered utility models - a four-wave laser microrefractometer, a universal laser microrefractometer and a device for measuring piezoelectric coefficients of dielectric materials.

Basic scientific and applied scientific contributions

The scientific papers presented in the competition are interdisciplinary and, as I mentioned above, can be divided into three areas. I characterize the **basic scientific contributions** as "*obtaining and proving new facts*" and formulate main scientific contributions in each of the above defined areas as follows:

Area 1: Polyelectrolyte multilayer systems on polymer substrates

- The deposition of polyelectrolyte multilayer (PEMs) structures deposited on polymer substrates with potential application as drug carriers on the oral mucosa has been optimized. In order to ensure an excess of charge on the surface of the substrate and to fascilitate the attachment of the polyelectrolytes, an innovative approach has been used, namely pre-treatment of the substrate with corona discharge. It was found that the type, structure and polarity of the substrate affect the structure and stability of the PEMs. The dependence of the properties of the layers on both the pH and the ionic strength of the polyelectrolyte solutions was observed (*publications № 1, 15, 17, 18, 23, 34, 38, 39, 43 from the presented list*);

- The most suitable type of substrate for binding chitosan and xanthan was determined, and the effect of the type of substrate and the polarity of the corona discharge was studied (*publication № 18 of the presented list*);

- The influence of the structure and physicochemical properties of the chitosan / casein multilayer films on their potential application as drug delivery systems was studied (*publication № 34 of the presented list*);

- The possibility of using the studied PEM / polymer substrate as drug delivery systems has been confirmed by drug release tests using the kinetics of benzydamine hydrochloride (*publication № 39 of the presented list*);

- It has been found that crosslinking improves the stability of multilayer structures, promotes the formation of a porous surface, which leads to an increase in the amount of immobilized drug several times (*publication № 42 of the presented list*).

- It is studied the effect of the number of xanthan and chitosan polyelectrolytes layers and their arrangement in the PEM structure, as well as the time of immobilization on the activity of the immobilized enzyme β-galactosidase for possible future applications for the production of galactooligosaccharides with prebiotic potential (*publications № 25 and 29*).

Area 2: Food research

- Methods have been developed for the detection of counterfeits of cold-pressed olive oils, comprising relatively inexpensive sunflower oil. The methodology is based on various physical approaches, such as measurement of refractive indices, fluorescence spectra, color characteristics, differential scanning calorimetry and combinations thereof (*publications № 6, 13 and 16 of the presented list*);

- Methods have been developed for identifying the botanical origin of honey and recognizing natural honey from "counterfeit" one. The first is based on laser refractometry, UV-VIS and FTIR spectroscopy, electrical conductivity measurement and differential scanning calorimetry (*publication № 30 of the presented list*). The second uses the measurement of refractive indices and glass transition temperature (*publication № 8 of the presented list*);

- The developed refractometric methods were used to determine the refractive indices of aqueous solutions of several commonly used sweeteners (*publication № 28 of the presented list*). The additional measurement of the optical density makes it possible to characterize the dispersion of the milk by determining the sizes of the casein micelles (*publication № 14 from the presented list*);

- A method for monitoring the properties of apples during aging based on impedance spectroscopy has been developed as a fast and non-destructive method. The observed changes in the measured spectra are related to the relative humidity of the studied objects (*publication № 3 from the presented list*).

Area 3: Application of corona discharge to modify and / or improve the properties of the studied objects

- Holographic recording was performed in structures comprising As_2S_3 and metal (Ag, Au and Cr) layers in the electric field of a corona discharge using evanescent wave, created by total internal reflection and normally incident plane one. The mobility and photodiffusion of metal ions (Ag, Au and Cr) in thin chalcogenide films were studied (*publications № 7 and 9 of the presented list*);

- The possibility of fine tuning of the refractive index of thin layers of polymethyl methacrylate (PMMA) by adding different concentrations of nanosized titanium dioxide particles with sizes smaller than 33 nm and treatment in the electric field of corona discharge has been demonstrated. The refractive index increases with doping and corona treatment (*publication № 10 of the presented list*);

- The influence of the concentration of TiO_2 particles with an average size of 500 nm on the electret properties of polypropylene composite films was studied. A significant change in the electret behavior of the composites was found at different levels of doping. The surface potential decay depends on the polarity of the corona discharge and the concentration of the particles (*publication № 4 of the presented list*);

- Electret films of polylactic acid with different degrees of crystallinity were deposited and treated with corona discharge. It has been established that by changing the degree of crystallinity and the parameters of the corona discharge, films with preset values of refractive indices and surface potential can be obtained (*publication № 2 of the presented list*);

As the main **applied scientific contributions** I define the following:

- Four and five - waves laser microrefractometers have been developed for measuring the refractive indices of thin layers and liquids with improved sensitivity. An universal laser microrefractometer, allowing measurement of complex refractive indices of scattering and absorbing samples has been also developed (*publications № 5, 11 and 12 and registered utility models № 46 and 48 of the presented list*);

- A device for measuring piezoelectric coefficients of a wide range of dielectric materials has been developed, providing high accuracy of measurements and possibility for precise control of the pressure on the sample (*registered utility model № 47 from the presented list*);

- A resistive ammonia sensor based on a composite film of polyaniline and polylactic acid has been developed, operating in the range of 10 ppm to 1000 ppm (*publication № 26 from the presented list*).

Significance of the results obtained and personal contribution of the applicant

I believe that the results obtained by Dr. Bodurov and his basic and applied scientific contributions are significant for the fields of materials science and physics of condensed matter in which he works. As proof, I will mention the fact that so far his publications have been cited more than 50 times (according to a reference in Scopus from October 2020), which can be regarded as an evidence of the interest shown by the scientific community in the results obtained. It should be taken into account that 70% of the scientific papers presented in this competition have been published in the last 5 years, so I expect the number of citations to increase.

According to Dr. Bodurov's personal contribution, I can definitely say that it is beyond any doubts. The applicant’s research is interdisciplinary and requires a team of different experts, which is a typical case of modern research and explains the existence of author teams. In 11 of the scientific publications, Dr. Bodurov is in the first place in the author's team, i.e. it is assumed that he has a leading role in research. I have known Dr. Bodurov from the time he started his as a full-time PhD student at IOMT-BAS and I follow his career even after he moved to the University of Plovdiv. I think he is a motivated and very hard-working young scientist who can conduct independent research.

Critical remarks

My critical remarks concern only the presented annotation of the materials, which lacks well-formulated contributions, but is rather a collection of summaries of all papers. I think that for a reviewer who is not familiar with the work of the applicant, it will be difficult to distinguish his personal contribution in each paper.

CONCLUSION

After getting acquainted with the materials presented in the competition and based on my personal observations and impressions I can without hesitation conclude that Assistant Professor Dr. Ivan Bodurov is a young promising scientist with experience in the field of condensed matter physics. Although he is young, he already has reach teaching and administrative experience and good project activity. The results and contributions obtained are significant. The applicant fully meets the minimum national requirements, exceeding them significantly in groups Г and D.

Based on all written above, I give my positive assessment and strongly recommend the esteemed Scientific Jury to support the application and to propose to the Faculty Council of the Physics and Technology Faculty of PU "Paisii Hilendarski" to award Assistant Professor Dr. Ivan Panayotov Bodurov the academic position "Associated Professor" in the professional field 4.1. Physical sciences.

Sofia, October 20th 2020

/Prof. Dr. Tsvetanka Babeva/