

## REVIEW

by prof. Plamen Ivanov Zagorchev, PhD, DBS

Scientific specialty "Biophysics", Department of Medical Physics and Biophysics, Medical  
University - Plovdiv,

Address. " Medical University of Plovdiv", Plovdiv, Bulgaria, 15A Vasil Aprilov Str,  
on the materials submitted for the competition for the academic position (AP) of Professor  
at the University of Plovdiv "Paisii Hilendarski"

field of higher education Natural Sciences, Mathematics and Informatics, professional field  
Physical Sciences

### 1. General presentation of the materials received

By Order No. RD-21-330 of 15.02.2023 of the Rector of Plovdiv University "Paisii Hilendarski" (PU) I have been appointed as a member of the scientific jury of the competition for the academic position of "Professor" announced in issue No. 92 of the State Gazette of 18.11.2022 in the field of higher education Natural Sciences, Mathematics and Informatics, professional field Physical Sciences (Physics of Condensed Matter) for the needs of the Department of Physics at the Faculty of Physics and Technology.

In the advertised competition only one candidate has applied:

Maria Georgieva Marudova-Zivanovic, PhD, Associate Professor at the Department of Physics, Faculty of Physics and Technology of Paisii Hilendarski University.

The submitted set of materials on paper and electronic media is in accordance with

the procedure for the acquisition of the AP "Professor" at Paisii Hilendarski University of Technology, as well as with the Regulations for the Development of Academic Staff at the University of Technology (DAS at the University of Technology) and with the Law for the Development of Academic Staff in the Republic of Bulgaria (LDASRB) and includes the following documents:

- a model application to the Rector for admission to the competition;
- a CV in European format;
- higher education diploma with Master's degree - a notarised copy;
- doctorate degree - notarised copy;
- diploma for the academic position "Associate Professor" - notarized copy;
- list of scientific works;
- scientific works (copies of publications);
- certificate of compliance with the minimum national and add. requirements;
- declaration of originality and authenticity of the attached documents;
- annotations of the materials referred to in Article 76 of the DAS in the PU;
- extended habilitation reference
- self-assessment of contributions;
- list of citations;
- document of work experience;
- documents on teaching work;
- documents on research activities and other documents.

Associate Professor Maria Georgieva Marudova-Zivanovich, PhD, has enclosed a total of 60 scientific papers, 1 chapter of a collective monograph, 1 university text-

book and 1 textbook. A list of participation in 1 international and 6 national scientific research projects, as well as a document for scientific supervision of 2 national scientific projects is presented. Documents for scientific supervision of 1 successfully defended PhD student - Stoil Penev Zhelyazkov, 2015 are also presented. 57 scientific works, which are outside the publications for the acquisition of the educational and scientific degree "Doctor", are accepted for review and 2 teaching aids and 9 research projects are considered in the final evaluation. 2 scientific works related to the acquisition of the PhD degree in 2007 and 17 scientific works applied for the award of the PhD degree are not reviewed. Invention patent document Reg. N 67404 B1 with evidence of potential economic impact was submitted.

The list of documents is correctly prepared, carefully arranged and all required full-text content is attached.

## **2. Brief biographical details of the applicant**

Assoc. prof. Maria Georgieva Marudova-Zivanovich, PhD, was born on 03.06.1974 in Plovdiv. In 1998 she obtained her Master's degree in Engineering Physics, specialization in Polymer Physics at the Faculty of Physics of Plovdiv University and in 1999 she was appointed as Assistant Professor at the Department of Experimental Physics at the same Faculty. In 2007 she successfully defended her PhD in the scientific specialty 01.05.06 "Chemistry of High Molecular Compounds". Since 2009 she has been working as an Associate Professor at Plovdiv University in the professional field of Physical Sciences (Physics of Condensed Matter). Her teaches courses in the field of general physics and polymer materials. The scientific interests

of Assoc. Prof. Marudova-Zivanovic are in the field of biopolymers and their applications in pharmaceuticals and food science. The specializations and workshops held in England (2001-2003 and 2011), France (2011) and Hungary (2015) are important in her establishment as a specialist in the field of biomaterials. She speaks English, Russian and Hungarian to varying degrees. She is a member of the Union of Physicists in Bulgaria and serves on the editorial board of 2 journals.

### **3. General description of the candidate's activity**

#### **3.1. Evaluation of the candidate's teaching and training activities**

Assoc. prof. Marudova has been a lecturer at the Department of Experimental Physics ("Physics") since 1999. Mechanics, Molecular Physics, Mechanics and Molecular Physics, Fundamentals of Polymer Science, Application of Polymers in Medicine, Experimental Methods in Physics, Fundamentals of Electronics, Nanomaterials and Nanotechnologies, Polymers in Electronics and Telecommunications. According to the presentation by Assoc. prof. Marudova for 5-year period (2017-2022) has a total of 2767 hours of lectures and exercises, which according to the requirements of the PU is a sufficient number of hours to hold the academic position of professor. The average annual teaching load of Assoc. prof. Marudova in this period was 553.4 lecture hours. She has developed 19 curricula in the above mentioned disciplines, as well as in the disciplines taught by her in the Master's degree programme - Mechanics and Molecular Physics, Polymer Materials, Mechanics, Rheology and Texture of Foods, Polymers in the Food Industry, Physicochem-

istry of Foods. She has participated in the development of 8 curricula in BSc (Engineering Physics), MSc (Physics of Food and Physics of Condensed Matter) and PhD (Structure, Mechanical and Thermal Properties of Condensed Matter and Physics of Condensed Matter). She has supervised 4 PhD students, 1 of whom successfully defended, and 16 successfully defended graduate students. She has published a textbook on "Mechanics" and co-authored a textbook "Guide to Laboratory Exercises in Physics".

### **3.2. Evaluation of the candidate's scientific and applied activity**

The materials submitted for the competition for the academic position of Professor were developed after the acquisition of the academic rank of AP Associate Professor and include 40 publications, 1 book chapter, 1 patent, 1 textbook, 1 teaching aid and 7 e-courses. Participation in 1 International project, 8 National projects and 7 University projects, participation in 18 international scientific forums and in the editorial board of 2 specialized scientific journals.

- All publications for the competition are in journals that are refereed and indexed in world-renowned databases of scientific information (Web of Science and/or Scopus).
- 20 of the publications participating in the competition are in journals with an impact factor with a cumulative IF of 41.36 according to the journal's data for the year of publication
- h-index 10 (according to Scopus)

- 13 publications included in a habilitation thesis for the award of AP Professor. Four publications with Q1 (100 points), 2 with Q2 (40 points), 2 with Q4 (24 points) and 5 publications in SJR journals without impact factor (50 points) - 214 points in total. The habilitation paper meets the minimum requirements and exceeds them more than twice.
- 27 publications in Scopus refereed and indexed journals. Three publications with Q1 (75 points), 3 with Q2 (60 points), 4 with Q3 (45 points), 9 with Q4 (108 points) and 8 publications in SJR journals without impact factor (80 points) Total 383 points.
- Assoc. Prof. Marudova, PhD is co-author of a collective monograph published abroad and of a book chapter and submits a document for patent of invention Reg. N 67404 B1 Total 40 points. Thus, for Group D, with a minimum of 200 points, the candidate scores 423 points i.e. 223 points more or indicator D is exceeded by more than 100%.
- A total of 14 of the full-text publications were printed in journals with IF (total IF = 19.37), in 4 of the above publications she was the lead author.

### **3.3. Analysis of materials for indicators C, D and E**

For indicator C 4. Habilitation work - scientific publications in journals that are refereed and indexed in world-renowned databases

A habilitation paper is presented with results of 13 thematically determined scientific publications, refereed and indexed in Web of Science and/or Scopus. 41 citations of the selected original scientific articles are documented.

The focus is in the development of multilayer nanoscale polyelectrolyte structures from natural polymers for application as drug-delivery systems. The layer-by-layer technology

used is environmentally friendly and is based on the post-vapor adsorption of two oppositely charged polymers on a charged polyester support - polylactic acid (PLA), poly- $\epsilon$ -caprolactone (PEC). For modification of the surface of the substrates a corona discharge is used - an invention of the Physics and Technology Faculty of Plovdiv University. Two pairs of natural polymers, chitosan/xanthan and chitosan/casein, approved for medical applications, were worked with by two methods - immersion in solution and spreading. The influence of the two factors pH and ionic strength of the solutions in the electrostatic interaction process was optimized. Methods such as X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), UV-VIS-NIR spectroscopy, laser refractometry, atomic force microscopy (AFM), differential scanning calorimetry (DSC), etc. were used to characterize the nanoarchitecture of the layer.

Three types of drug substances, benzidamine hydrochloride (BZ) and betahistine dihydrochloride (BET), which have high solubility in water, and tolfenamic acid (TA), which dissolves well in ethanol and basic buffer solutions, were included in the study. Different kinetic models were applied to the experimental data to provide information on the release mechanisms.

After a complete characterization of physical, physicochemical, mucoadhesive properties and release rate, it is found that a system of 8 polyelectrolithic layers of chitosan/xanthan containing BZ obtained after double cross-linking of chitosan with glutaraldehyde and trisodium polyphosphate can be interpreted as an optimal drug-delivery system when applied on buccal mucosa. The system is biocompatible with a surface pH within the physiological range, it is stable with moisture absorption is and with mucoadhesive potential.

The personal contribution of the candidate, Assoc. prof. Marudova, PhD, in the attached 13 publications consists in the development and obtaining of:

- Nanostructured, polyelectrolyte multilayer drug delivery systems for buccal application and their roughness analysis
- biopolymer substrates for deposition of polyelectrolyte multilayer films and analysis of SEM results
- polyelectrolyte multilayer films of chitosan and xanthan on substrate under varying pH and ionic strength
- corona-charged polylactic acid substrates and analysis of layer topography
- Multilayer polyelectrolyte structures with potential for drug-delivery systems and investigation of surface morphology by AFM

Of note, the significant contribution of the professor candidate in:

- Conducting the drug release experiments from the monolayer structure
- establishing the influence of pH and ionic strength on the release of benzidamine hydrochloride from a chitosan/casein multilayer system
- the study of a flexible polyelectrolyte multilayer structure with selection of crosslinking agents in drug delivery and the study of the in vitro release kinetics of benzidamine hydrochloride.
- The layer-by-layer construction of films for buccal drug delivery: the effect of polymer crosslinking
- selection and preparation of polylactic acid/poly- $\epsilon$ -caprolactone multi-component substrates



- characterization of multilayer films and investigation of the physical content of drug substances by DSC.

- As in the overall manuscript layout of the submitted papers.

### **3.4 For indicator D: Scientific publications in journals that are refereed and indexed in world-renowned databases of scientific information**

The personal contribution of the candidate, Assoc. prof. Marudova, Ph.D., in the design, preparation, implementation of the scientific idea, manuscript preparation and scientific analysis of the 27 publications submitted is without any doubt.

Innovative biopolymer nano-multilayer films with medical applications have been developed: their chemical and physical properties under varying external factors, architecture and release kinetics have been studied. Methods for the preparation of the edible films are presented. Their properties have been studied and a significant range of plant oils have been characterized.

A method for the preparation of a water-insoluble glucan by an enzymic transferase reaction is patent protected.

**3.5 For indicator E, the citations of the candidate's scientific work are 90 and carry 180 points, against the required 100 points - a performance of 180%.**

**3.6 For indicator F Supervision of a successfully defended PhD student (25 points), participation in 6 national projects (60 points), one international scientific project (20 points), supervision of 2 national scientific projects at the National Research Fund (40 points) with a value of 345 000 BGN. University textbook and manual (43 points). Performance on indicator F 151%.**

### **3.7. Analysis of the significance of contributions in the candidate's scientific works**

#### I. Scientific and applied contributions

- Polyelectrolyte multilayer structures of pectin/chitosan and, for the first time, of chitosan/casein were created on corona-charged substrates of

1. polylactic acid.

2. poly- $\epsilon$ -caprolactone

- The type of growth of polyelectrolyte layers from chitosan/casein was found to depend on the polarity of the substrate

- The structure of the layers was found to be affected by

1. the preparation technology

2. the pH and ionic strength of the solvent

- Crosslinking of the chitosan/casein multilayer structure with different crosslinkers was carried out, where the amount of incorporated BZ increased sevenfold

- The performance of the drug-delivery system as well as the release kinetics for BZ, etc. were optimized.

- The physical properties of polymer films were analysed, as

1. the degree of crystallinity of a polylactic acid film and the mass ratio of the poly-L-lactic acid and poly-DL-lactic acid stereoisomers involved
2. the cross-linking of macromolecules and the change in the temperatures of dissolution and melting under the influence of ionising radiation
3. the rate of release of salicylic acid after complexation with chitosan and by the hydrophobic properties of poly-lactic acid.

- A set of physical methods is proposed

1. for the authentication of food products
2. to monitor the properties of apples as they age
3. to investigate the thermal properties of mixtures of sucrose and sweeteners such as erythritol, sorbitol and maltitol

- Phase transitions were characterised by the DSC method

1. in the case of chia seed, elder, coriander and cumin seed oils
2. poultry pastes enriched with vegetable components
3. and a correlation between cooling rate, type and stability of crystalline structure has been established.

- The rheological behaviour of gluten-free flours - rice, corn, chestnut and sweet potato - was characterised

- The processes of glutarization and retrogradation in starch were investigated by DSC method.

- An electrical sensor (reaction time 100 s) was developed for ammonia registration (10 ppm to 1000 ppm) based on a composite film of polyaniline and polylactic acid.

- An optical sensor for the registration of ammonia (above 60 ppm) based on a composite

film of metal-organic structure (trimesic acid - Co(II)) and polylactic acid is presented. The response time of the sensor is between 2 min and 12 min depending on the ammonia concentration.

- Development of edible packaging based on biopolymers

1. multi-component film of hydroxypropyl methylcellulose, grape seed oil, potato starch and clove oil

2. monolayer (chitosan) and bilayer (chitosan/alginate)

## II. Contributions to teaching

The presented textbooks and e-courses (Mechanics; Molecular physics and thermodynamics; Physics 1 - mechanics and molecular physics; High molecular weight-actions; Application of polymers in medicine and biotechnology; Fundamentals of electronics; Polymers in electronics and telecommunications) are intended for students studying at the Faculty of Physics and Technology of Plovdiv University as well as for students from other higher education institutions.

The TABLE shows the scores achieved by the candidate against the scores required by law. Correlation of the scores achieved with the minimum required scores according to the Regulations for the Implementation of the Law on Academic Staff Development of Paisii Hilendaski University by groups of indicators for the position "Professor".

<b>Group of indicators</b>	<b>Minimum required points according to the Law</b>	<b>Academic Achievement of Assoc. prof. Maria Marudova-Zivanovic, Ph.</b>
B	100	214 (performance 214%)
D	200	223 (performance 212%)
E	100	180 (performance 180%)
F	150	226 (performance 151%)

It is an honour for each candidate for AP Professor to submit a performance table for all required metrics with a minimum of 150%. We see 214% performance in materials submitted in lieu of a habilitation paper. With such metrics, the candidate's recognition among the scientific community is unquestionable. Some of the developments are practice-oriented, have been implemented in production and have an economic effect. Some innovative ideas are protected by a patent. The candidate has inter-national recognition and has been a lecturer at the Corvinus University of Budapest, Hungary on numerous occasions during 5 academic years as well as at the Athens University of Technology, Greece. She is a member of the editorial board of Polymers, MDPI and Bioengineering International. She is involved in 2 international projects.

#### **4. Evaluation of the personal contribution of the candidate**

The personal contribution of Associate Professor Maria Marudova-Zivanovic, PhD in the

materials submitted for re-review is undoubtedly proven, I fully accept the presented results as well as the formulated contributions.

## **5. Critical remarks and recommendations**

I have none, I am fully satisfied with the presented documents and the way they are systematized.

## **CONCLUSION**

The documents and materials submitted by Associate Professor Maria Georgieva Maru-dova-Zivanovic, PhD meet the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria, the Regulations for the Implementation of the Law on the Development of Academic Staff in the Republic of Bulgaria and the relevant Regulations of the Paisii Hilendarski University.

The candidate has presented a significant number of scientific works published after the materials used in the defense of the PhD and in the competition for the acquisition of the AP "Professor". They exceed the required number by many times. The candidate's works contain original scientific and applied contributions that have received international recognition, a representative part of them having been published in first- and second-quartile journals. The theoretical developments have practical applicability, together with numerous developed lecture courses, textbooks and study guides.

The scientific and teaching qualifications of Associate Professor Maria Georgieva Marudova-Zivanovic, PhD are unquestionable. Demonstrated results in teaching and research activities, exceeds almost two times the national requirements, as well as those of the regulations of the PU for the application of the Law on Research and Development.

The materials submitted for review show that Associate Professor Marudova, PhD possesses the necessary knowledge and versatile practical skills to plan and precisely conduct scientific research in physics, chemistry and pharmacy, as well as the skills to analyze the data obtained. The professor candidate can train undergraduate and graduate students to generate ideas and innovations, work in a team, and lead research programs.

After the analysis of the presented scientific production, its significance, as well as the original scientific, scientific-applied and applied contributions, I find it more than justified to give my positive evaluation and to recommend the Scientific Jury to prepare a report-proposal to the Faculty Council of the Faculty of Physics and Technology for the election of Associate Professor Marudova, PhD to the academic position of "Professor" at Paisii Hilendarski University in the field of higher education Natural Sciences, Mathematics and Informatics, professional field Physical Sciences.

30.03. 2023

Reviewer: .....

prof. Plamen Zagorchev, PhD, DBS