REVIEW

of the competition for the occupation of the academic position of
ASSOCIATE PROFESSOR
In the field of higher education 5. Technical sciences, professional specialty 5.1. Machine engineering, scientific specialty Applied mechanics (mechanics of coatings)

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With single applicant, Senior assistant PhD Eng. Polina Ilieva Milusheva-Mandadjieva

Reviewer: Prof.Dr.Eng. Mara Krumova Kandeva-Ivanova
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1. General information and biographical data

PhD Eng. Polina Milusheva-Mandadjieva is the only applicant in the competition for the occupation of the position of Associate professor in the field of higher education 5. Technical sciences, professional specialty *5.1. Machine engineering, scientific specialty Applied mechanics (mechanics of coatings)* opened by the University "Prof.Dr. Asen Zlatarov" – Bourgas for the Department of "Electronics, electrical engineering and machine engineering", Faculty of technical sciences. She graduated her first master's degree "Machine engineering in the Faculty of Engineering and Pedagogy - Sliven at the Technical University of Sofia (1993-1998) and her second master's degree "Industrial management", specialty "design engineering" at the University "Prof. Dr. Asen Zlatarov" – Bourgas (2016-2018).

In 2016, Polina Milusheva-Mandadjieva successfully defended her dissertation for the educational and scientific degree of "Philosophy Doctor" at the Technical University – Sofia, higher education field *5 „Technical sciences", professional specialty 5.1 „Machine engineering", scientific specialty „Materials science and technology of machine building materials"* under the scientific guidance of Assoc. Prof. PhD Tsanko Uzunov and Prof. PhD Atanas Atanasov. The abstract of her thesis entitled "Metal coatings on polymeric materials" is in the scientific field of the present competition and presents a profound research at high scientific level.

Since 2011, the applicant works as lecturer-assistant (2011-2015) and Senior assistant (since 2016) in the Department of "Electronics, electrical engineering and machine engineering" at the University "Prof. Dr. Asen Zlatarov" – Bourgas and two years before she was invited lecturer at the same Department.

Senior assistant PhD Eng. Polina Milusheva is member of the Union of Scientists in Bulgaria and member of the editorial board of the Journal *"Science, Education, Culture"*, ISSN 1314-717 X, in the Republic of Bulgaria.

She participates in five scientific research projects planned by the Scientific Research Sector at the University "Prof. Dr. Asen Zlatarov" – Bourgas. The autobiographical data indicate for staunch civic activity and very successful teamwork.

2. General description of the presented materials

For the present competition for the position of Associate professor, Senior assistant PhD Eng. Polina Milusheva has submitted all the documents required according to the Regulations on the conditions and order for occupying academic positions at the University "Prof. Dr. Asen Zlatarov" – Bourgas. The presented documents are neatly arranged and their contents make it possible to make clear estimation of the scientific research, applied research and the teaching activity of the applicant. The materials are absolutely relevant to the topic of the competition.

According to the presented Declaration for the number of points by indicators, the applicant participates in the competition with a total of 40 publications arranged into two groups: *group V* (10 pieces) and *group G* (30 pieces). After thorough analysis of the publications, I make the following statements:

In group V, a total of 10 publications were submitted; they were published in journals referenced and indexed in world-known scientific databases. Among them, publication *V1* is the same as publication *№3* of the PhD Thesis and it is not accepted. However, it can be substituted by publication *G4* from the *G group* which has been published in the Journal *„Trakia journal of sciences"* (ISSN 1313-7050) which is indexed in world-known scientific databases and has impact ranking. Thus, the number of publications in journals referenced and indexed in world-known databases remains 10. *The total number of points in group V is 480 which is 4 times higher than the minimum number of points required – 100 according to the requirements of the University "Prof.Dr. Asen Zlatarov" – Bourgas.*

In group G, scientific publications in non-referenced journals with scientific reviewing or in redacted collective volumes, the applicant participates with 30 publications. Scientific publications *G1, G3 and G9* are the same as publications *№ 1, 2 and 4* in the PhD Thesis and cannot be accepted. Publications *G2, G5 and G8* are published in journals which were not found in the National register and are also dropped. Publication *G21* is published in Proceedings of the International conference in Leipzig, Germany. The rest are published in journals listed in the National reference list of referenced journals. After dropping the publications mentioned above, the applicant was asked to add another 2 publications: the first one is in press and will be published in the *Journal of the Balkan Tribological Association, 26(5), 2020 г., (ISSN*

1310-4772) in which PhD P. Miluisheva is the single author. The second one is published in the *Proceedings of the annual university scientific conference, V.Tarnovo, May 2020, pp. 1808-1816, electronic edition, (ISSN 2367-7481)*. In this paper P. Milusheva is the leading author of two co-authors.

Based on the considerations described above and after the reduction of the points for the dropped out publications and addition of the points for the additional publications, *the total number of points for indicator G became 332 which exceeds the minimum number of points – 300 as stated in the requirements of University "Prof. Dr. Asen Zlatarov"- Bourgas.*

In the information about the citations, 32 observed citations are presented which are listed in indicator *D*12* (citations or reviews in scientific journals referenced and indexed in world-known databases with scientific information or in monographies and collective issues (Scopus; Web of Science, etc.) - 5 citations (5x10=50точки) and in indicator *D*14* (citations or reviews in non-referenced journals with scientific reviewing) – 27 citations (27x2=54точки).

After careful analysis of the list of citations presented in indicator *D*14*, I found that there are 13 citations in this group which should be classified into group *D*12*, namely:

- Paper №2 has been cited in 2 scientific publications in JBTA which is indexed in Scopus and Web of Science;
- Paper №3 has been cited in 2 scientific publications in JBTA which is indexed in Scopus and Web of Science;
- Paper №4 has been cited in 3 scientific publications in JBTA which is indexed in Scopus and Web of Science;
- Paper №5 has been cited in 3 scientific publications in JBTA which is indexed in Scopus and Web of Science, индексирано в Scopus и Web of Science;
- Paper №6 has been cited in 1 scientific publication in JBTA which is indexed in Scopus and Web of Science;
- Paper №8 has been cited in 2 scientific publications in JBTA which is indexed in Scopus and Web of Science;

As a result, it can be summarized that a total of 18 citations are listed in indicator D*12, i.e. 180 points (18x10=180 точки) while 14 publications remain in indicator D *14, i.e. 28 points (14x2=28 точки).

The total number of points for citations in indicator D is 208 which is higher than the minimum number of points required which is 100 according to the requirements of University "Prof. Dr. Asen Zlatarov"- Bourgas.

3. General characterization of the scientific research and applied research activities of the candidate

In the materials presented for the competition, the main scientific achievements and results obtained from the scientific and applied research work of the applicant are in the field of synthesis and complex studies of metal coatings deposited by magnetron ionic sputtering in vacuum onto polymeric materials which can be applied in various branches of industry.

The work on the dissertation work range a wide spectrum of interdisciplinary research connected with the effects of the technological parameters on the geometrical, physicochemical, mechanical and tribological properties of deposited onto polymeric materials. Major part of the studies is of experimental nature due to the complexity of the contact interactions taking place in the system "substrate-coating".

Senior assistant PhD Eng. P. Milusheva has participated in 5 scientific research projects financed by the Scientific research sector at the University "Prof. Dr. Asen Zlatarov" and co-author in two patent applications - № 112894 / 18.03.2019 and № 112901/ 04.04.2019 on the topic of this competition.

4. Estimation of the pedagogical competence and activities of the candidate

Senior assistant PhD Eng. Polina Milusheva is full time lecturer in the Department of "Electronics, electrical engineering and mechanical engineering" since 2011. Her lecturing and pedagogical activities is connected with the development of lecture courses for the educational and qualification degrees of Bachelor and Master for regular and correspondent forms of education, elaboration of new and updating the existing curricula for the different specialties.

It becomes clear form the information about the disciplines and lecture courses permanently included in the curricula that Senior assistant PhD Eng. Polina Milusheva gives lectures and seminars on Mechanics, Technical mechanics, Mechanics I, Materials resistance, Computer modelling, Printing and preprinting preparation, etc., to students in more than 10 specialties of both regular and correspondent forms of education.

It can be seen from the information about the educational load that Senior assistant PhD Eng. Polina Milusheva has had substantial amount of educational activity for the last three years. For the last academic year 2019/2020 her total lecturing hours were 585.

Senior assistant has published 1 textbook *"Technical Mechanics"* as single author, electronic issue (2020, CD, ISBN 978-619-91493-0-0) and 1 handbook *"Collection of Problems in Technical mechanics"*, electronic issue (CD, ISBN 978-619-91493-1-7).

5. Main scientific and applied science contributions

The main scientific and applied science contributions resulting from the activities of Senior assistant PhD Eng. Polina Milusheva can be categorized as development, study and application of new composite coatings and thin surface layers onto polymeric materials, acquiring new knowledge and deepening existing ones in the fields of mechanics and materials science. In the reference about the contributions presented, the information is clearly and in details structured and presented in four main directions:

- Deposition of metal, graphene and wear resistant coatings onto polymeric materials.
- Studies of the mechanical properties of deposited coatings and the surface properties of thin layers.
- Simulation studies and optimization of mechanical structures with deposited coatings.
- Other directions.

The scientific and applied science contributions in each of these directions are described in detail.

The contributions found in the works submitted for the competition can be summarized as follows:

- Comprehensive scientifically based studies were carried out and new results were obtained for the processes of formation of several types of coatings and layers by magnetron sputtering in vacuum – metal X18H9T, Ti, Al, Ni-Cr and TiN coatings onto polymers PS/SB190 crystal, PS/SB793 shockproof and POLIPOM®-POM; Pt-SiO_2; layers deposited onto polytetrafluoroethylene substrate by high frequency cathode sputtering; deposition of copper nano-coating by high voltage technology; deposition of mono-layer of graphene onto polymeric material PS/SB793 shockproof and tribologic wear resistant coatings of aluminium oxide onto polyamide structures Polipa®PA6 and Polikes®PA6G by direct current magnetron-ionic sputtering. New qualitative and quantitative relationships were obtained for the influence of technological regime parameters – temperature, voltage, vacuum level and duration of the process of sputtering on basic geometric, physicomechanical and tribological characteristics of the contact system "polymer-coating" such as coating thickness, thermal resistance, adhesion strength, microhardness, wear resistance, normalized elasticity modulus E^*, degree of the plastic energy of deformation W_r, total energy of deformation W_t, morphology of the coatings. Modern methods and techniques were used in the studies (publications V4-2, V4-5,V4-7, V4-8,V-10, G-7).

- The possibilities to deposit the coatings and layers mentioned above was proved, as well as their practical implementation in various branches of industry, e.g. hybrid and monolith integral circuits, reflective and selective coatings in optics; possibilities to employ alloyed targets resulting from the recovery of nickel and chromium from industrial waste waters; improvement of the electric and capacitive properties of surfaces and development of electrodes for new-generation supercapacitors by deposition of copper nano-coatings and graphene coatings; wear resistant coatings from steel X18H9T and Ti deposited onto machine elements manufactured from the polymeric material POLIPOM®-POM; wear resistant coatings from aluminium oxide deposited onto polyamide structure Polipa®PA6 and Polikes®PA6G, **using** fluidized bed technology, etc. (publications G8-4, G8-7).

- A new approach and method were suggested for simulation and prediction of the geometric, mechanical and tribological of the coatings studied, optimization of the deposition regimes at selected main criteria: adhesion strength, micro-hardness and wear resistance. Simulations with complex external loads of normal force, bending and twisting moments acting on the system "substrate-coating" for which, after comparing to the physical experiments with coatings of X18H9T and Ti deposited onto POLIPOM®POM, excellent correspondence of the results was observed. The methods allows shortening time and saving resources for experimental studies to determine the desired thickness of the coating which is an expensive and time consuming procedure(publications V4-2, G8-27, G8-30).

- A physical and mathematical model was developed which describes the stresses arising between the coating and the substrate under external load and the influence of adhesion. The model has been applied in an assembly of axial bearing unit of a steam turbine working with Freon and with electric generator mounted within the turbine. Complex external loads of normal force, bending and twisting moments on the elements contained in the assembly were simulated. Using the results obtained from the simulation, a radial-axial bearing unit was designed for turbine with embedded electric generator of 16 kW electric power and working with Freon 507A under heat-carrier inlet pressure 1,5 MPa and debit of 0,122 kg/s. The simulation results obtained were compared to experimental data registered during turbine operation and the correspondence observed was good. This proved the possibility to apply the method suggested in the design of non-standard equipment (publications V4-2, G8-4, G8-7, G8-26, G8-27, G8-30).

- A mathematical apparatus for theoretical determination of the deformation of polymer structure located on horizontal plane and subjected to ageing by solar radiation. Possible solutions of the task of enhancement of aircraft reliability by using composite materials were studied, analyzed and proved. An investigation of the working capacity of a ship after impact was carried out on the basis of simplified idealization where the ship was modelled as a system consisting of subsystems containing its basic elements. A mathematical model for determining and predicting the reliability of a ship after impact was obtained which includes possibilities for repairing the damaged systems. A mathematical formulation for determining the function of failure distribution was suggested which would allow estimating the probability of working capacity after impact (G8-11, G8-12, G8-16, G8-17, G8-19, G8-20, G8-22, G8-24).

6. Significance of the contributions to science and practice

It can be seen from the materials submitted for participation in the competition that the lecturing and scientific research activities of Senior assistant PhD Eng. Polina Milusheva are well known to the Bulgarian and international colleges.

I am obliged here to emphasize on the undisputable relevance of the applied science research issues studied related to one of the main tendencies in tribology and materials science aimed at increasing the resource of the contact surfaces in parts, mechanisms, devices and machines

In my opinion, the quantitative indicators of the criteria for occupying the academic position of "Associate professor", as determined in the Law on the Development of the Academic Staff in the Republic of Bulgaria and the requirements of the Regulations for acquiring scientific degrees and occupying academic positions in the University "Prof. Dr. Asen Zlartarov" – Bourgas are far exceeded.

7. Critical notes and recommendations

I have no critical notes on the essence, as well as on the technical presentation of the materials for the competition.

8. Personal impression and opinion of the reviewer for the candidate

I have excellent impression of Polina Milusheva as a specialist in the field of materials science, mechanics and composite coatings which I personally acquired from her participation in the international conferences *BULTRIB* organized by the Society of Tribologists in Bulgaria and the Balkan Tribologic association. From our contacts concerning problems in the field of tribology and after careful reading the documents presented for the competition I can state that Senior assistant PhD Eng. Polina Milusheva is purposeful researcher with highly responsible attitude to the scientific

and lecturing problems, profound thinking, able to make creative analysis and summarizing the facts. She is well organized, precise and positively social person, she has many skills, including successful work in a team. Her publications are well known to the Bulgarian and international colleges.

CONCLUSION

In my opinion, the candidacy of Senior assistant PhD Eng. P. Milusheva-Mandadjieva is suitable for the academic position of "Associate professor". The evidence presented (publications, citations, etc.) comply with the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations for acquiring scientific degrees and occupying academic positions in the University "Prof. Dr. Asen Zlartarov" – Bourgas

I am fully convinced and I recommend to the respectful members of the Scientific jury to vote positively for awarding the academic position of *"ASSOCIATE PROFESSOR" to Senior assistant PhD Eng. Polina Ilieva Milusheva-Mandadjieva in the scientific specialty Applied mechanics (Mechanics of coatings).*

Sofia, 04.08.2020 г.

Reviewer:

/Prof. Dr. Mara Kandeva-Ivanova /