

REVIEW

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of the materials submitted for participation in the competition to occupy an academic position "**Professor**" in: area of higher education: **5. Technical Sciences** professional field: **5.6. Materials and Materials Science** specialty: "**Materials Science and Technology of Machine-Building Materials**"

In the competition for a professor, announced in the State Gazette, no. 47 of 24.06.2022 and on the TU-Gabrovo website for the needs of the "Materials Science and Mechanics of Materials" department at the "Mechanical and Precision Engineering" faculty, Angel Petrov Anchev participated as the only candidate.

1. Short CV data

Angel Petrov Anchev was born in 1976. In 1995, he graduated from secondary special education, majoring in "Industrial electronics - electronic computing technology" at the Technical High School of Electrical Engineering "M. V. Lomonosov" in the town of Gorna Oryahovitsa. In 2000, he graduated with a degree in "Technique and technologies for the protection of the natural environment" at the Technical University - Gabrovo. In 2006, he defended a dissertation on the topic "Increasing the load-bearing capacity and fatigue life of structural elements with cylindrical holes by means of spherical turning" and obtained a PhD degree in a scientific specialty 01.02.02. "Applied Mechanics". From 2004 to 2016, he was successively an assistant and chief assistant in the departments of "Chemistry and Ecology" and "Technical Mechanics" at TU-Gabrovo. From 12.2016 until now, he is an Associate Professor in the "Technical Mechanics" and "Materials Science and Mechanics of Materials" departments. In 2020, he was elected as head of the "Technical Mechanics" department, transformed in 2021 into the "Materials Science and Mechanics of Materials" department. The candidate has good skills in English, Russian and German languages, as well as various software products - SolidWorks, Labview, Mathcad. He possesses good communication and teamwork skills, as well as skills for planning, organization and conducting experimental work.

2. General description of the presented materials

All necessary materials are presented on electronic media. They are in full compliance with the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), the Rules for its Application and the Rules for the Acquisition of Academic Degrees and the Occupancy of Academic Positions (RAADOAP) at TU-Gabrovo. The candidate has also submitted additional lists of participation in projects, prepared and delivered lectures on certain disciplines, printed textbooks and a graduates guidance.

According to the report presented, Associate Professor Angel Anchev, PhD, Eng., meets and in most cases far exceeds the national requirements and those of TU-Gabrovo for the employment of AP "Professor".

2.1. Requirements of LDASRB

- Indicator A – 50 points out of the required 50 points for a dissertation work for awarding PhD degree;
- Indicator B4 – 127.14 points out of the required 100 points for habilitation work – scientific publications (not less than 10) in journals that are referenced and indexed in world-renowned scientific information databases;

- Indicator G – 270.78 points out of the required 200 points, which are subdivided as follows:
 - 94.09 points for G7 - scientific publication in journals that are referenced and indexed in world-renowned databases with scientific information and
 - 176.69 points for G8 - scientific publication in non-refereed journals with scientific review or in edited collective volumes.
- Indicator D - 1594 points out of the required 100 points, including:
 - 1580 points from D12 - citations or reviews in scientific publications, referenced and indexed in world-famous databases with scientific information or in monographs and collective volumes and
 - 14 points from D14 - citations or reviews in non-refereed journals with scientific review.
- Indicator E – 170.66 points out of the required 150 points, including:
 - 40 points from E17 – guidance of a successfully defended doctoral student;
 - 10 points from E18 – participation in a national scientific or educational project;
 - 60 points from E20 – management of a national scientific or educational project;
 - 6 points from E22 – attracted funds for projects managed by the applicant;
 - 34.66 points of E23 - published university textbook;
 - 20 points from E24 – published university textbook.

2.2. Requirements of TU-Gabrovo

- 38 articles presented, of which 5 individual and 21 with IF (WOS) in necessary 30 (5 individual and 3 with IF (WOS));
- Presented 165 citations at 20 required;
- Presented 3 issued textbooks and 1 study book with 2 on demand;
- Successfully defended 2 doctoral students in the requirement for 1;
- Head of 3 research projects with 3 required.

3. Overview of the content and results in the presented works

3.1. Indicator B4 – habilitation work – scientific publications (not less than 10) in journals that are referenced and indexed in world-renowned scientific information databases.

The candidate submits 10 related scientific publications equivalent to a monographic work on the topic "Improving the performance behavior of diamond-burnished metallic materials by controlling the Surface Integrity (SI) characteristics". The topic of this work does not repeat the topic of the PhD thesis - "Increasing the load-bearing capacity and fatigue durability of structural elements with cylindrical holes by means of spherical mandrels". It is dedicated to improving the performance of aluminum bronze, low-alloy structural and austenitic chrome-nickel steels using the static diamond burnishing (DB) method. The idea of applying this method to increase the surface hardness and operational characteristics of metal materials arose on the basis of a thorough analysis of data from the literature, made in the first chronologically published article 1.B.10. Further, within 4 years, a large volume of experimental work was carried out. Conventional, modern (3D optical profilometry) and combined methods (test and finite element analysis) were used to study surface characteristics, microstructure, residual stresses, hardness, wear resistance and fatigue resistance. The results were processed using regression and dispersion analyses, and the optimal technological parameters of the DB process were found, leading to improved SI characteristics - minimum roughness and maximum hardness, which determine the maximum fatigue limit and high wear resistance. Following the chronology, the presented scientific publications are thematically related and they examine the properties of representatives of three groups of the most commonly used industrial metal materials – aluminum bronze CuAl8Fe3 (publications 1.B.1 – 1.B.4), low alloyed structural steels 37Cr4 and 41Cr4 (publications 1.B.5, 1.B.6, 1.B.8 and 1.B.9) and austenitic chromium-nickel steel AISI 304 (publication 1.B.7). The main scientific contributions relate to: 1) developed optimization procedures of the parameters of the diamond burnishing process, which allow control and prediction of the fatigue behavior of the studied materials by controlling the Surface Integrity and 2) an outlined area of application

of the diamond burnishing process based on the created integrated classification of static methods. Contribution I-1 from scientific is rather scientific-applied because it refers to one material and not to a whole group. The papers contain 11 scientific-applied and 8 applied contributions, which present data on the properties of the studied materials. I cannot accept contributions I-3 of the scientific-applied and 3 of the applied, because the first relates to a comparison between two methods of surface treatment without specified results, and the second presents statistical data from a literature review.

The analysis carried out shows that **the presented scientific articles are equivalent to a habilitation thesis, which corresponds to the topic of the specialty of the procedure and is characterized by a high scientific value.** They have been published in journals with an **overall impact factor (IF) of 31.9 and have been cited in international journals with an IF of more than 34 times.** Nine of the articles are in Q2 quartile journals and one in a Q3 quartile. The papers were published in the Journal of the Brazilian Society of Mechanical Sciences and Engineering - 2, The International Journal of Advanced Manufacturing Technology - 3, Materials and Manufacturing Processes - 1, Journal of Materials Engineering and Performance – 1, Materials – 1, Fatigue and Fracture Engineering Materials and Structure – 1 and Arabian Journal for Science and Engineering – 1.

The obtained results and especially the procedures for optimization the technological parameters of the diamond burnishing process are of great practical interest for increasing the operational characteristics and durability of the details in various branches of industry.

3.2. Indicator G7 - scientific publication in journals that are referenced and indexed in world-renowned databases with scientific information

This section presents 12 articles with a **total impact factor of 28.9, published in journals with quartiles Q2 - 9 articles, Q3 - 1 article and Q4 – 1 paper.** Half of the articles - 6 pcs. are published in the Journal of the Brazilian Society of Mechanical Sciences and Engineering, 3 pcs. – in The International Journal of Advanced Manufacturing Technology, 1 pc. – in Fatigue and Fracture Engineering Materials and Structure, 1 pc. – in Strength of Materials, 1 pc. – in Journal of Materials Engineering and Performance, 1 pc. in Metals and 1 pc. in Journal of Physics: Conference Series, indexed in Scopus with SJR 0.21.

In the presented articles, the influence of the parameters of the processes of diamond burnishing and surface plastic deformation (SPD) with a toroidal roll on the fatigue behavior of aluminum alloy 2024-T3 Al is investigated (1.G.1, 1.G.7, 1.G.8 and 1.G.9). A new method and tool has been developed for cold plastic deformation of a large number of small fastener holes in 2024-T3 Al alloy to increase fatigue strength (1.G.3). A thermomechanical 3D finite element (FE) analysis of the DB process with nonlinear kinematic strengthening (1.G.10) was performed. Optimization procedures of the DB process for 41Cr4 steel have been developed to obtain optimal values of roughness and fatigue limit (1.G.4 and 1.G.6). The influence of two methods: friction stir hole expansion and solid mandrel cold working and symmetric cold expansion on increasing the fatigue life of aircraft parts made of aluminum alloy D16AT (1.G.5) was evaluated. A new technology has been presented for the processing of holes in the joints of the railway rails by means of a DB, which leads to an increase in crack resistance (1.G.2). The influence of the electron beam power on the microstructure and mechanical characteristics of electron beam welded joints of copper and stainless steel was investigated (1.G.11).

3.3. Indicator G8 - scientific publication in non-refereed journals with scientific review or in edited collective volumes.

Sixteen papers are presented, that have been published in proceedings of the "Unitech"-Gabrovo conference - 1 pc. and journals "Mechanical Engineering and Mechanical Science" - 6 pcs., "Mechanics of Machines" - 2 pcs. and "Journal of Technical University Gabrovo" - 7 pcs.

In them, the microstructural changes, the micro-hardness and the surface roughness of D16T aluminum alloy processed by DB (3.G.1, 4.G.1 and 4.G.2) were investigated. A constitutive model was created and a finite-element modeling of the deformed state of the surface layer of aluminum alloy 2024-T3 subjected to SPD with deforming rollers (4.G.5 and 4.G.6) was carried out, and the residual stresses were investigated as well (4.G.9). The roughness of aluminum alloy 2024-T3 sub-

jected to SPD with a toroidal roller (4.G.10) was investigated. A new tool with K-profile was developed and its technological capabilities for SPD of small holes were evaluated (4.G.3 and 4.G.4). The micro-hardness of the surface of 41Cr4 and AISI 304L steels, processed by grinding and smoothing by means of a toroidal roller (4.G.7 and 4.G.15), was investigated. The optimal parameters of the DB process for obtaining minimum roughness on the surface of low carbon steel S235, medium carbon steel 45 and tool steel Y8A have been established (4.G.8). The influence of diamond burnishing on the topography, friction coefficient, wear resistance and fatigue strength of CuAl8Fe3 bronze parts (4.G.11, 4.G.12, 4.G.13 and 4.G.14) was investigated.

The content of publications under indicators G7 and G8 refers to the development of new technologies and tools, research into the microstructure and properties of a wide range of metals and alloys used in industry, aircraft construction and railway transport - copper and its alloys; aluminum alloys; structural, tool and austenitic stainless steels, which is in full accordance with the direction and specialty of the competition. A total impact factor in this group of the order of 29.8 is indisputable proof of the high scientific and applied value of the researched problems and the obtained results.

4. Reflection of the candidate's scientific publications in the scientific field

In this section, the candidate submits 165 citations of his scientific works, 158 of which are in journals with an impact factor, 1 in a dissertation for acquisition of Doctor of Science degree, 3 in PhD theses, and 3 in non-refereed peer-reviewed journals. A review in Web of Science shows that Assoc. Prof. Angel Anchev has 31 publications, 180 citations without self-citations and an H-index of 10. This confirms **the importance of the solved problems, the wide distribution and visibility of the results and the great international interest in the research done. Therefore, Associate Professor Angel Anchev is an established scientist known to the scientific community at home and abroad.**

5. Contributions

In the submitted report, the candidate claims 3 scientific contributions, 36 scientific-applied ones (18 in the section "Creation of new classifications, methods, approaches, algorithms, constructions, models, etc." and 18 in the section "Obtaining and proving new facts") and 11 applied. When compiling the contributions, it should be borne in mind that they are a synthesis of the conclusions to the publications, and the conclusions are a synthesis of the results obtained from the research conducted. Moreover, the technological parameters and properties are more related to the applied contributions, and microstructure, mechanical properties, etc. – to scientific and applied ones. It is in the light of these statements that my assessment of the candidate's contributions is made.

5.1. *Scientific contributions* – I accept the first two contributions as defined. Contribution 3 is mostly scientific-applied because it refers to a single material and not to a whole group.

5.2. *Scientific-applied contributions*

I. *Development of new classifications, methods, approaches, algorithms, constructions, models, etc* – I do not accept contributions numbered 1, 3, 7, 11 and 15 because they refer to a process of research, comparison, evaluation, optimization and do not present results obtained. Contributions 4 and 17 are applied because they refer to established optimal technological parameters of DB for austenitic steel and to geometrical parameters and deforming force in SPD with toroidal roll. I accept the rest of the contributions as defined.

II. *Obtaining and proving new facts* – I do not accept contributions with the numbers 8, 12, 14, 17 and 18, because they refer to the process of research, comparison, evaluation, determination, optimization and do not present obtained results. Contributions 1, 10 and 13 are applied, relating to the determination of optimal parameters of the DB process of aluminum bronze, aluminum alloy and steels. Contributions 3, 4, 9 and 11 talk about the effect of various parameters on fatigue strength, fatigue life and micro-hardness, without specifying what it is. I accept the rest of the contributions as defined.

5.3. *Applied contributions* – I accept contributions 3, 4 and 5 as defined. Contributions 1, 8 and 9 are more scientific-applied. Contributions 6, 7, 10 and 11, referring to obtaining S-N curves

of various materials, can be combined and classified to scientific-applied. Contribution 2 refers to statistical data from a review and I cannot accept it as a contribution.

Based on the critical analysis of the contributions, two of high scientific value clearly stand out, relating to: 1) establishing the essence of the influence of compressive residual stresses after SPD to increase the fatigue life of structural elements and 2) managing and predicting the fatigue behavior of the studied materials through optimization procedures of the parameters of the diamond burnishing process. There are also a sufficient number of scientific-applied and applied contributions that are original in nature. All of them refer to established topography, microstructure, mechanical and operational properties of a wide range of machine-building materials - aluminum alloys, bronzes and steels processed by methods of surface plastic deformation. The developed new tools, production processes and optimal technological parameters are of great practical application.

6. General description of the applicant's activity

6.1. Educational and pedagogical activity

From the attached references, it is clear that Associate Professor Angel Anchev gives lectures in 6 disciplines: Additive technologies, Digital prototyping, Computer simulations of systems and processes, Mechanics and resistance of materials, Technical mechanics, Mechanics 1 and 2 part. In these disciplines, he conducted **168 hours of lectures and 284 hours of practical classes during the past academic year 2021/2022**. The training includes full-time, part-time and business-oriented bachelor's and master's students. **In the first 3 disciplines, which correspond to the subject of the competition, the candidate has conducted 78 hours of lectures during the past school year, having also developed the lecture materials for them.** They are read to students from the following specialities: Materials Technology and Materials Science, Computer Technologies in Mechanical Engineering, and Computer Design.

The candidate presents for the competition 4 textbooks and study books and 2 more in a further reference. In this way, the requirements of LDASRB are met and those of TU-Gabrovo are exceeded. **Three, out of the 6 presented, are manuals and workbooks for solving tasks in statics, kinematics and dynamics. They are more in the field of mechanics, so I will not review them.**

- **I highly evaluate the textbook on "Metal Science and Heat Treatment. Part 2: Heat treatment of metals", published in 2022.** It very clearly, accurately and consistently defines the various types of heat treatments and gives information about technological processes of heat and chemical-thermal treatment of steels, cast iron, non-ferrous metals and alloys. The information in the textbook is very well illustrated with photographs and graphics. **With the synthesized information and additional data on the materials, the textbook can serve not only in the education of students at TU-Gabrovo, but also for specialists in industry.**

- **The book "Fatigue Life Increase of 202-24T3 Aluminum Alloy by Slide Burnishing", published by "Lambert Academic Publishing" in 2017,** refers to the study of the surface properties of high-strength aluminum alloy 2024-T3 after diamond burnishing. It is intended both for engineers working in the field of mechanical engineering to increase the fatigue strength of metal components, and for students. **I evaluate this work highly, but my opinion is that it is more of a scientific monograph than a textbook.**

- **The monograph "Diamond Burnishing", published in 2021, presents the results of multi-year research by a team of five authors** dedicated to SPD as an effective and economical approach to increase the fatigue strength and fatigue life of cyclically loaded metal components. It examines: the essence of Surface Engineering and Surface Integrity; the characteristics of SPD and diamond burnishing; the features of the DB process; DB of unhardened and hardened steels, high-strength aluminum alloys and aluminum bronzes; DB of holes in railway junctions. **I give extremely high evaluation of this work in terms of structure and content. Besides being very useful for mechanical engineering, the first 4 chapters can be successfully used in teaching students about SPD processes.**

Under the guidance of Assoc. Prof. Angel Anchev, 28 students from various majors have successfully defended their thesis. **He is the supervisor of 2 developed and defended PhD theses, which meets the requirements of TU-Gabrovo.**

6.2. *Scientific and scientific-applied activity*

The candidate has taken part in 6 university projects and 2 national projects - 1 in FSI and 1 in Science and education for intelligent growth. In 2 of the university and in the FSI project, Assoc. Prof. A. Anchev is the head, and in the others he is a researcher. It is important to note that the topics of all projects are in accordance with the scientific specialty of the competition. A high rating should be given to the candidate's work on the national projects KP-06-H47/6-26.11.2020 (FSI) "Investigation of processes and structural changes during electron beam welding of metals and alloys with different thermophysical properties", for which BGN 30,000 was attracted to TU-Gabrovo, and BG05M2OP001-1.002-0023 Competence Center "Intelligent Mechatronic, Eco- and Energy-Saving Systems and Technologies" 2019-2023.

7. Evaluation of the candidate's personal contribution

In the presented scientific publications, Assoc. Prof. A. Anchev is the individual author of 5 publications, first author of 3 publications, in second place in 10 publications, in 3rd place - in 16 publications and in 4th place - in 4 pcs. It is noteworthy that the articles in which he is the leading author were published mainly in Bulgaria. The candidate is **the sole author of the "Dynamics Tasks-Solving Guide" and the two study books for statics and kinematics course problems.** He is a member of the author collectives of the textbook on **"Metal Science and Heat Treatment. Part 2: Heat treatment of metals"** (2nd place), of the book **"Fatigue Life Increase of 202-24T3 Aluminum Alloy by Slide Burnishing"** (3rd place) and of the monograph **"Diamond Burnishing"** (4th place). It is not possible to assess the participation of the candidate in the last 3 sources, because they do not mention the participation of each author, which is the rule for scientific works issued by a collective of authors.

The participation of Assoc. Prof. A. Anchev in half of the articles and in the textbooks as sole, first or second author, the leadership of several projects not only on a university, but also on a national scale, the successful leadership of graduates and doctoral students unequivocally speak of his main role when conducting the research and presenting the results on the one hand and the organization, provision and implementation of the educational process on the other.

8. Critical remarks and recommendations

Against the background of the large volume of scientific research work, carried out constantly by the candidate from his admission to TU-Gabrovo until now and together with his educational and teaching activities, his low participation in conferences makes an impression. Only 3 publications from proceedings of such events, organized mostly in Bulgaria, are presented. Bearing in mind the high scientific potential and language training of Associate Professor A. Anchev, I would recommend that he promote the results of his and his group's activities at international conferences abroad. This will lead to the establishment of much more useful contacts, participation in international projects and expansion of the connections of TU-Gabrovo in the networks of European universities.

I also have some questions and critical remarks to the candidate, which in no way diminish the value of his work. In the point about contributions, I clarified the concept of how they are formed. Additionally, I would like to point out that when writing conclusions and contributions, it is appropriate for greater clarity not to indicate abbreviations such as FE, DB, SI, etc., regardless of the fact that they are defined in advance in the text. Since the conclusions and contributions are a synthesis of the results, it is not necessary to mention the method by which they were obtained, unless it is newly developed. In addition, specific values related to the studied parameters and characteristics must be indicated.

I have some questions, based on the written above:

- To specify what is the influence of the combination of the micro- and macro-effect on the fatigue life of DB samples (Contribution II-3 from the scientific-applied)?

- To specify what is the influence of the coefficient of cyclic loading and the number of transitions on the fatigue behavior of samples processed by DB (Contribution II-4 from the scientific-applied)?
- To specify what is the influence of the number of transitions and the presence of lubrication on the microhardness of D16T aluminum alloy samples subjected to diamond burnishing (Contribution II-9 of the scientific and applied)?
- To specify what is the micro-effect during the processing of samples of high-strength aluminum alloy 2024-T3 during plastic deformation by means of diamond burnishing (Contribution II-11 from scientific and applied)?

9. Personal impressions

I have known Assoc. Prof. Angel Anchev for three years. He made an impression on me with his responsiveness, organization, accuracy and strict execution of the assigned tasks. He is very competent in the field of computer technology and the application of software products. All this, together with relatively good skills in 3 foreign languages - Russian, English and German, and his knowledge of mechanics help him to adequately analyze problems in the field of materials and technologies and propose complex solutions.

CONCLUSION

Based on the above, I propose that **Assoc. Prof. Angel Petrov Anchev, Ph.D., Eng., be elected as "Professor"** in the area of higher education **5. Technical Sciences**, professional field: **5.6. Materials and Materials Science**, specialty: **“Materials Science and Technology of Machine-Building Materials”**

25 October 2022
Varna

Reviewer:/signature/.....
(Prof. Tsanka Dikova, DSc)