REVIEW

about the dissertation submitted for acquiring the academic degree

"**Doctor of Science**"

Author of the dissertation: Assoc. Professor Dr. Tsanka Dimitrova Dikova

Topic: Properties of additively manufactured dental materials

Reviewer: Professor Dr. Lubomir Vankov Dimitrov

The dissertation has 6 chapters and covers 260 pages. The main results and conclusions are placed at the end of each chapter, and all of them, together with the description of the contributions, are summarized in the last section of dissertation.

1. The topic of the dissertation in the context of the main trends in science and practice. Novelty of the main problems discussed in the dissertation and of the results acquired.

The problem discussed in the dissertation is placed on the truncated point of three extremely fast developing fields in modern science and industry:

- New materials, and in particular those applicable in dental practice. In recent decades, the production of new, more effective materials, in accordance with the specifics of their application, is carried out by an exponential law. This requires continuing research and experimentation in order to ensure the effective and rapid use of these materials in details with guaranteed physical and mechanical properties.

- 3D technologies for additive production on micro and nano levels. 3D technology has developed extremely fast in recent years, being used very frequently to produce elements in which damage layers should be around 50 μm. This problem in dental practice is extremely important and up to date and to its solution is dedicated the dissertation under review. 3D technologies addressed in the work are: stereolithography with laser or with digital light projection; details production by material plating; inkjet printing and multi-jet printing; selective melting with electron beam; selective laser sintering and selective laser melting.

- the application of information technologies in design and production (CAD/CAM/CAE). These technologies facilitate the development, control and process management and are now an integral part of the modern industry.

On the basis of what was said above, I find that the topic of the dissertation under review is extremely up-to-date. The dissertation examines the development and improvement of the three strands mentioned in a specific application, dentistry, which is developing extremely intensively. There are still a number of unresolved issues in this area. Some of those issues have been solved in the dissertation of Tsanka Dikova.

2. Degree of familiarity with scientific literature and novelty of interpretation.

The candidate has made a detailed survey of the publications in the area of the dissertation – this survey covers 33 pages and includes two main sections:

- An overview of the technologies for production of dental material made by layers;
- Overview of dental materials and dental constructions, for which technologies for layer production are applicable

The author has analyzed a huge amount of publications – 359, of which 18 in Bulgarian and others – in foreign languages. At the end of the chapter are drawn the appropriate conclusions and on the basis of the scientific literature studied are formulated the main tasks that the dissertation approaches.

The author had the beneficial opportunity to specialize abroad and to use rich libraries which she has exploited in the best way and has consulted publications valuable for her research. She had specializations at the University of Rice, Huston, USA (Fulbright Program), University of Tokaj, Hirsuka, Japan, St. Petersburg Sea Technical University, St. Petersburg, Russia. She has also worked on a research project financed by the Bulgarian Ministry of Education, Scientific Research Fund.

3. Compliance of the chosen research methodology with the intended purpose and tasks of the dissertation.

The main goal and the particular tasks of the dissertation are formulated at the end of chapter one, based on the conclusions derived from the literature overview.

Four main tasks have been defined to achieve the goal. The content of the thesis corresponds to the intended purpose and formulated tasks.

The second chapter of the dissertation is devoted to the methodology of the study and covers the following elements: the elaboration of the test specimens; examination of accuracy and roughness; examination of density, microstructure and chemical composition; hardness determination; examination of tensile strength and adhesion of coatings to dental alloys; examination of bending strength; examination of tribological and corrosion properties. All sub-sections of the methodology cover both experimental studies and simulations. The chosen methodology for testing and the methods prescribed in the chapter for conducting experiments and simulations fully cover the intended purpose and tasks in the dissertation work.

4. Short analytical characteristic of the nature and assessment of the reliability of the material on which are based the contributions of the dissertation

In its main part, this dissertation is experimental. The tasks in it are solved through experimental research and simulation analyses. The experiments made by the author, Assoc. Prof. Ing. Tsanka Dikova, include examination and application of new materials and new 3D technologies in dental practice. The dissertation also shows the results of the testing of samples of new dental plastics and alloys; results of their tensile test, hardness, measured roughness, adhesion of porcelain coatings on alloys, their tribo-corrosion qualities; as well as examination of patterns of dental bending bridges. All the experiments have been made with precise modern equipment, which allows me not to doubt the reliability of the measurements. The credibility of experimental studies has been confirmed through Solidworks simulation analyses.

5. Scientific and scientifically-applied and applied contributions of dissertation work.

The contributions formulated by the author of the dissertation are of scientific and applied nature. Scientific contributions are 6.

I would define contribution 1.1 as "formulation and justification of a new theory".

I would qualify contribution 1.2 as "proving with new means of existing theories and hypotheses" as well as

contribution 1.3. as “creation of new methodology”;

contributions 1.4. and 1.6. as “new technology”;

I would qualify contribution 1.5 scientifically-applied because it is the basis of the theory developed and reflected in the contribution 1.2. Perhaps it is better to unite contributions 1.2 and 1.5.

The author has divided the contributions of a scientifically-applied nature into two groups: those of "original character" (9) and those of "confirmatory character" (7).

The candidate has formulated 3 applied contributions.

All the contributions are justified and proven in dissertation work. I find them indisputable, especially the significance of the contributions concerning the use of alloys Co-Cr and Co212-F, through the use of 3D technologies, as well as porcelain coatings to Co-Cr alloys in dental practice.

6. Assessment of the degree of personal participation of the applicant in the contributions of the dissertation.

What I see is that the contributions of this scientific work are results of the personal work of the applicant and they originate from the experiments, simulations, and analyses made by her.

7. Assessment of candidate’s publications (indicator Г/100): number and characters of her publications and their impact in science: use and citation by other authors, in other laboratories, countries and others (indicator Д)

The candidate has submitted documents for 24 publications (on the subject of dissertation work), distributed as follows: individual: 5, of which one chapter in a book, 2 papers in referable journals and 2 in conference proceedings. 11 of these publications are in SCOPUS database and 8 are published in scientific journals and conference proceedings. At present in SCOPUS database Assoc. Prof. Tsanka Dikova has a total of 17 publications, 11 citations and she has H-Factor of 3. The total SJR factor of her publications is 2.905, and her impact factor (IF) is 4.737.

The candidate has submitted a list of 7 individual books, textbooks and teaching materials and one with a co-author.

The publications are included in the indicator **Г** of the Minimum requirements of the Bulgarian Law for Academic Staff Development and TU-Gabrovo

regulations. The candidate has 177.3 points for the indicator **Г** with minimum required 100 points.

The publications presented cover most of the studies and models made. They fully reflect the contributions formulated in the dissertation.

22 citations are presented in the materials submitted by the applicant. They are distributed as follows:

- In scientific journals, referenced and indexed in world-famous databases with scientific information – 12 citations;
- In unreferenced journals with scientific review-9 citations;
- In a master diploma thesis defended abroad – 1 citation.

Totally in item **Д** she has 106.0 points with minimum required 100 points.

The applicant publications and citations show once again that the results of the dissertation thesis have received public inspection and approbation amongst the specialists in the particular scientific area.

8. **Use of the results of dissertation thesis in scientific and social practice. Economic effect. Documents witnessing this use.**

The candidate states that the results of her work have been implemented in practice at the Faculty of Dental Medicine (FDM) – Varna, and also that they are included in the training programs for the students of "Dental medicine and dental technician" in FDM and the Medical College of Medical University – Varna. No implementation documents have been applied.

9. Assessment of the conformity of the abstract with the requirements for its preparation, as well as the adequacy of the coverage of the contributions of the dissertation.

The abstract adequately reflects the main problems and achievements of the dissertation under review. It clearly presents the main ideas in the thesis chapters. The objectives and methodology of the study are reflected. Also, in it, the contributions and publications related to the dissertation are described. The text covers 92 pages. All figures are in color which facilitates their perception. The text is written in clear and comprehensible.

10. Recommendations and notes.

I have no critical remarks to the dissertation and its main scientific and applied contributions. Still, I would suggest to the author to specify the standard according to which the tribological tests were made (p. 72, last paragraph of dissertation thesis: "5N load, speed 0.01 m/s, distance 100 m for 3 1/2 h") so that it will become possible to verify their authenticity.

Further, I would encourage the candidate to work more for the implementation of the results of her work in practice and to contribute or lead more scientific group projects.

11. Conclusion with a clear positive or negative assessment of dissertation.

In my judgement, in terms of volume and quality of the research done and of the contributions of the study, the dissertation of Assoc. Prof. Dr. Eng. Tsanka Dimitrova Dikova fully satisfies the requirements of the Bulgarian Law for Academic Staff Development and the rules for its application for conferring the academic degree “Doctor of Sciences”. The quantitative indicators of the "Rules of procedure for acquisition of scientific degrees at TU-Gabrovo" for acquiring the scientific degree "Doctor of Sciences" are also covered.

My detailed acquaintance with the dissertation under review "Properties of additively manufactured dental materials", as well as with the other materials of the procedure and with the overall academic activity of the candidate as a researcher and lecturer, give me a good reason as a member of the jury to vote positively for the decision the academic degree of “Doctor of Science” to be conferred to Assoc. Prof. Dr. Eng. Tsanka Dimitrova Dikova in the professional field 5.6 “Materials and Material Science", the scientific specialty "Material Science and Technology of Machine Building Materials".

Date: 07.06.2019 **REVIEWER: /signature/**

Prof. L. Dimitrov