



## OPINION

by

Assoc. Prof. Dr. Desislava Konstantinova, DMD, PhD,  
Department of Dental material science and Prosthetic dental medicine,  
Faculty of Dental medicine, MU- Varna, member of the Scientific jury,  
according order № P-109- 137/23.02.2023 of the Rector of MU – Varna

*Regarding:* acquisition of the educational and scientific degree "doctor" in the field of Higher education 7. Health care and sport. Professional domain: 7.2. Dental medicine. PhD – Program: "Orthopedic Dentistry"

**PhD Thesis: "Adhesion of dental ceramics to Ti6Al4V alloy, fabricated by CAD/CAM technologies"**

**Author: Dr. Yavor Vasilev Gagov**, full time PhD student, Department of Dental material science and Prosthetic dental medicine, Faculty of Dental medicine, MU- Varna

*Scientific supervisors:* 1. Prof. Tsanka Dikova, DSc and 2. Assoc. Prof. Dr. Iveta Katreva, PhD, DMD

### *1. General presentation of the procedure:*

The submitted dissertation work of Dr. Yavor Gagov is in a form and volume that meet the requirements of the Law on the Development of the Academic Staff of the Republic of Bulgaria (LAD), the Regulations for the Implementation of the Law on the Development of the Academic Staff in Bulgaria (RILAD) and the Regulations for a development of the academic staff of MU - Varna. It contains 152 pages, it is structured correctly and in good scientific language. It is illustrated with 63 figures and 14 tables. The bibliography covers 185 titles - 28 are in Cyrillic and 157 are in Latin.

### *2. Biographical data:*

Dr. Yavor Gagov was born on March 11, 1982. In 2010 he graduated from the Medical University of Plovdiv with the qualification "Master of Dentistry". Since 2014 he has been a full-time assistant at the Department of Prosthetic Dentistry, MU - Varna. In 2022 he acquired a specialty "Prosthetic dental

medicine” at the Medical University of Varna. He declares that he is fluent in English and Russian. He is a member of BDU.

### *3. Evaluation of the actuality of the topic and characterization and evaluation of the dissertation work:*

The topic of Dr. Gagov's dissertation is current and concerns the application of titanium and its alloys in dentistry, supported by modern CAD/CAM technologies.

The purpose of Dr. Gagov's dissertation work is to investigate the adhesion of dental ceramics to Ti6Al4V alloy produced by CAD/CAM technologies.

For the optimal achievement of the goal, the author has set himself 4 main tasks, which are well formulated (2 of them have subtasks). The development of the dissertation follows their logical resolution:


1. To investigate the properties of Ti6Al4V alloy made by milling and selective laser melting:
  - 1.1. To examine the geometric characteristics and density;
  - 1.2. To examine the morphology and roughness of the surface;
  - 1.3. To test the hardness and determine the modulus of elasticity.
2. To conduct an experimental study of the adhesion strength of dental ceramics to Ti6Al4V alloy made by milling and selective laser melting:
  - 2.1. To determine the adhesion strength in application of different surface treatments;
  - 2.2. To investigate the fracture mechanism of the coating;
3. To determine the adhesion strength of porcelain to Ti6Al4V alloy by finite element analysis.
4. To develop a laboratory protocol for manufacture of metal-ceramics from Ti6Al4V alloy, produced by CAD/CAM technologies.

Materials and methods are presented clearly and in detail.

The results and their analysis are supported by a sufficient number of figures and statistics. Along with the results of each task, there is also a short discussion, in accordance with the literary scientific sources, among which a significant part of Bulgarian authors.

### *4. Contributions of the dissertation work:*

The doctoral student's contributions are based on the overall analysis of the information on the literature review, the experimental material, the analysis







and the discussion of the own results. They reflect a significant part of the sections analyzed.

The following contributions are presented:

## 1. Scientific-applied contributions:

### 1.1. Original:

A new methodology for determining the modulus of elasticity has been developed, which is based on a bending experiment and finite element analysis;

For the first time, the topography of a Ti6Al4V alloy was investigated using ADC (amplitude distribution curve) curves of the surface profile of the samples.

The features of the topography of the surface of milled and laser-built Ti6Al4V alloy before and after sandblasting were established.

The values of the modulus of elasticity of the Ti6Al4V alloy were determined according to the newly developed methodology: 180 GPa for the milled and 120 GPa for the SLM manufactured samples.

A different influence of the surface treatments of the metal base on the adhesion strength was found: sandblasting and combined treatment increased the adhesion strength of the porcelain to the milled samples, but reduced it to those made by SLM.

The normal, tangential and equivalent von Mises stresses at a point at the edge of the porcelain coating and the bonding agent sublayer were determined.

The normal stresses along Y-axis, acting perpendicular to the interface between porcelain/metal, bond/metal or porcelain/bond, were found to be the highest and lead to predominantly adhesive failure of the coating from the metal surface.

### 1.2. Confirmatory:

It has been confirmed that the roughness of the samples produced by SLM ( $R_a=6.7 \mu\text{m}$  and  $R_z=36.36 \mu\text{m}$ ) is several times higher than the milled ones ( $R_a=0.86 \mu\text{m}$  and  $R_z=4.61 \mu\text{m}$ ). Sandblasting reduces the roughness of laser-built parts by about 10%, but almost doubles the roughness of milled parts. The microhardness of Ti6Al4V alloy was confirmed to be higher in the laser built samples (396 HV) compared to the milled ones (347 HV).

It has been confirmed that the adhesion strength of the porcelain coating to the titanium alloy produced by both methods has close values: 17.63 - 30.89 MPa for the milled and 22.12 - 31.04 MPa for the laser-built alloy.

It has been confirmed that the destruction of the ceramics occurs by a mixed adhesion-cohesion mechanism, with a difference in the layer in which the adhesion or cohesion failure occurs.

## 2. Applied contributions:

For metal-ceramic constructions of Ti6Al4V alloy, fabricated by milling/SLM and coated with VITA LUMEX AC porcelain, the application of a VITA NP BOND PASTE bond sublayer is not recommended because it reduces adhesion.

Two laboratory protocols were developed for the production of metal-ceramic fixed dental prostheses from Ti6Al4V alloy, fabricated by CAD/CAM milling and selective laser melting.

## 5. Abstract:

The abstract reflects the main parts and sections of the dissertation work and meets the requirements of LAD, RILAD and the Regulations for the Development of the Academic Staff of the MU – Varna.

## 6. Publications related to the topic of the dissertation:

Dr. Yavor Gagov has presented a list of 3 publications in technical journals on the topic of the dissertation. He is the third and fourth author.

## 7. Conclusion:

The submitted dissertation is up-to-date, well-structured, contributing, in form and volume complying with the requirements of LAD, RILAD and the Regulations for the Development of the Academic Staff of the MU – Varna. This gives me the reason **to vote positively** for awarding of the educational and scientific degree "doctor" in the field of Higher education 7. Health care and sport. Professional domain: 7.2. Dental medicine. PhD – Program: "Orthopedic Dentistry".

04/04/2023  
Varna

Sincerely:   
Assoc. prof. Dr. D. Konstantinova, PhD