# REVIEW

## on dissertation work
### for the acquisition of the educational and scientific degree "Doctor" in field of higher education – 5. Technical Sciences
### professional direction – 5.6. Materials and Material Science
### doctoral program – „Materials science and technology of engineering materials "

**Author:** Eng. Simeon Tsankov Tsenkulovski
**Topic:** „Peculiarities of laser marking of layer-reinforced composites on a polymer basis"
**Reviewer:** Professor Jordan Maximov, DSc, PhD

## 1. Relevance and novelty in the dissertation work
Despite the fact that the processing of materials with concentrated energy flows has been applied for more than five decades, it is becoming increasingly relevant due to its enormous potential and areas of application. The dissertation is based on a conceptual model for the development of a laser installation for marking layer-reinforced composite materials on a polymer basis, which installation eliminates the shortcomings of existing systems. Therefore, the relevance and novelty of the dissertation work are beyond doubt.

## 2. Cited literature
The literature used contains a total of 186 sources, of which 46 are in Cyrillic, distributed as follows: 1) in Cyrillic: books – 23, textbooks – 5, conference reports – 5, articles – 8; dissertations – 3; regulatory documents – 2; 2) in Latin: books – 20, articles – 69, conference reports abroad – 9, dissertations – 4, patents – 1, internet addresses – 29, others – 8. There are cited articles in high-level Elsevier journals such as the Journal of Materials Processing Technology. However, the articles are only cited, there is no specific analysis of those of them that are directly related to the problem posed in the dissertation. Given the analysis of the literature, I believe that the dissertation candidate is familiar with the features of laser technologies, and in particular with those for marking. On this basis, the goal of the dissertation work and the tasks for its achievement are formulated.

## 3. Research method
Given the specificity of the problem being treated, the main research method is the field experiment.

## 4. Brief description of the material on which the contributions are formulated
Chapter 1 outlines the place of laser processing as a method of concentrated energy flow processing and laser marking as a subdivision of this processing. A detailed analysis of the existing technological solutions in laser marking systems with the necessary conclusions is made. On this basis, the goal and objectives of the dissertation are defined.

Chapter 2 contains information about equipment, materials and methods. This chapter contains the core of the dissertation, namely a conceptual model for creating a laser marking system that would overcome the shortcomings of existing systems. This seems too ambitious and deserves admiration.

Chapter 3 is obviously intended to present the theoretical foundations of the ongoing heat exchange processes.

In Chapter 4, for two materials (glass textolite and textolite), the influence of selected control factors of the laser marking process, implemented with the innovative system, on the depth and width of the marking, and on the profile of the cross-section of the marking stroke, is experimentally investigated. In this chapter, a factor space scan (pre-planning of the experiment) was performed.

In Chapter 5, for both materials, an experimental study was performed, subject to a planned experiment, and the results were processed by ANOVA and regression analyses using QStatLab software. The main effects of ANOVA, i.e., the significance of each of the two controlling factors, and regression polynomial models were shown. Finally, multi-objective optimization was performed.

## 5. Contributions of the dissertation work

The author has tried to present the contributions concisely and precisely, which is commendable. However, I have edited, summarized, and classified the contributions I have acknowledged as follows:

*A. Scientific-applied contributions*

A.1. Creation of new classifications, methods, constructions, models, methodologies, algorithms

♦ Conceptual model for the development of a laser installation for marking layer-reinforced polymer-based composites.

♦ Mathematical models of the influence of beam power and marking speed on the penetration depth and width of the laser line in laser marking of glass textolite and textolite.

A.2. Obtaining and proving new facts

♦ The responses of two materials (glass-textolite and textolite) in terms of marking line characteristics caused by the parameters of the laser marking process have been established.

*B. Applied contributions*

• Workable laser installation for marking layer-reinforced polymer-based composites.

## 6. Publications on the dissertation

The author has made a total of 10 publications, as follows:
1) 4 reports at scientific conferences in Bulgaria;
2) 1 report at a scientific conference abroad (Rēzekne, Latvia);
3) 3 articles in journals in Bulgaria;
4) 2 useful models.

In all reports and articles, the doctoral student has a leading role (no information is provided about the authorship of the utility models).

Based on the above data, it can be concluded that the results of Eng. Simeon Tsenkulovski's dissertation have been disseminated and discussed well enough.

**7. Notes on the dissertation**

I highly appreciate the innovative work of the doctoral candidate in creating the laser installation. I have no comments of a principled nature.

I was a reviewer of the version of the dissertation presented at the pre-defense. This version contained numerous weaknesses, which I had described in detail in the previous review. The doctoral student took into account all my comments, answered the questions posed, and made the necessary revisions. The result is a nice, concise dissertation with a pronounced experimental character, with clearly highlighted conclusions and contributions.

However, there are some points that the doctoral student should pay attention to in his future work:

▪ The coefficient of conductive thermal conductivity is denoted by k in the table of accepted notations. But the flux concentration coefficient is also denoted by k.

▪ References 63 and 148 contain an incomplete bibliographic description.

▪ Without the obligatory in such cases mathematical justification for neglecting the exponential expression in formula (3.2), the following transformations to obtain formula (3.4) are unconvincing.

**8. Other questions**

1) I am impressed by the innovative and inventive activities of the doctoral candidate.

2) I strongly believe that the educational function of the doctoral training has achieved its goal. The doctoral candidate has significantly increased his knowledge in the field of laser technologies.

**9. Conclusion**

I believe that the presented dissertation "Peculiarities of laser marking of layer-reinforced composites on a polymer basis" with the author Eng. Simeon Tsankov Tsenkulovski meets the requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria. The achieved results give me reason to propose to the esteemed scientific jury to award the educational and scientific degree "Doctor" to Eng. Simeon Tsankov Tsenkulovski, in the field of higher education 5. Technical Sciences, professional field 5.1. Mechanical Engineering, doctoral program "Materials Science and Technology of Mechanical Engineering Materials".


20.08.2025                                        Reviewer:


                                        Professor Jordan Maximov, DSc, PhD