REVIEW

by Prof. Dr. Eng. Mara Krumova Kandeva-Ivanova, Technical University-Sofia,
regarding a dissertation for obtaining the scientific and educational degree "DOCTOR" in the scientific field 5. Technical Sciences,
professional field 5.2. "Electrical engineering, electronics and automation", scientific specialty "Automated information processing and management systems"

Author of the dissertation: GABRIELA VIKTOROVA KOCSEVA

Thesis topic: Mechanical and tribological studies of polymers and composites obtained by 3D printing

BASIS to prepare the review: Order No. 302/28.11.2025 of the Director of the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences on the appointment of a scientific jury and Decision of the first meeting of the scientific jury (Minutes No. 1 of 11.12.2025).

1. Relevance of the problem developed in the dissertation in scientific and scientifically applied terms.

The present dissertation work is focused on the study of mechanical and tribological characteristics of polymers and composite polymer materials obtained by 3D printing.

The main goal of the study is to develop, implement and analyze methodologies for experimental and simulation evaluation of the behavior of these materials under different loading conditions, seeking the relationship between the technological parameters of additive manufacturing, the geometry of the samples and their functional characteristics.

The topic is extremely relevant because it is directly related to contemporary global trends in the field of additive technologies (3D printing), materials science and tribology for the development of new materials with high mechanical, tribotechnical, economic and environmental performance.

The topic is not only scientifically interesting and interdisciplinary, but also practically significant. Its significance stems from the deep need to research and optimize the technologies, properties and functional characteristics of the obtained3D printed materials for their application in the diverse operating conditions of mechanisms and machines in various areas of industry and transport.

2. General characteristics of the presented dissertation work

The dissertation has a volume of 174 pages and its structure includes: introduction, five chapters, conclusion, scientific and applied contributions, bibliography, publications on the dissertation topic and two appendices. It contains 80 figures, 25 tables and 226 cited sources, of which 9 are in Bulgarian. A list of abbreviations and terms used is presented with the dissertation.

Chapter 1 is a literature review on the topic of the dissertation.

Chapter 2 describes some methodologies and devices for experimental studies of tribosystems involving polymers and composites, as well as devices for measuring the microhardness of polymers. Modern 3D printing techniques and their role in creating test parts are examined.

Chapter 3 presents the main methodologies and devices used in the preparation and study of polymers and polymer composites, in particular - 3D printing methodologies, methodologies for measuring hardness and microhardness, methodologies for determining static friction coefficients in sliding conditions and in rolling conditions on an inclined plane, methodologies for determining the coefficient of restitution and methodologies for creating simulations in the EDEM Software environment.

Chapter 4 presents the experimental results obtained with the selected and compiled research methodologies. Data are shown and a comparative analysis of the static coefficients of friction during sliding and rolling, of the coefficient of recovery upon contact between different polymers and polymer composites - PLA, PETG, CARBON, Steel Fil, TPU, Flex and Vero White is made. A significant part of this chapter is the validation of the experimental data through simulation studies with EDEM software.

Chapter 5 discusses possibilities for the future development of the topic of the dissertation. The experimental results obtained provide opportunities for expanding the spectrum of new materials and research through which the qualities of parts in 3D printing can be improved.

Another possible perspective being considered concerns the expansion of tribological research under different conditions and the application of 3D materials and composites in various contact systems of mechanisms and machines in industry.

3. Degree of knowledge of the state of the problem and creative interpretation of the literary material.

The literature review in Chapter 1 of the dissertation is presented in a volume of 38 pages. It represents an in-depth study of the current state of tribology as an engineering interdisciplinary science and additive technologies for 3D printing. The historical

development of tribology in the world and in Bulgaria is examined, basic concepts and terms, tribological phenomena and processes are described, as well as some standards and methods for determining tribotechnical characteristics. The 3D printing technologies, types and properties of the materials used (polymers and polymer composites) are presented.

The comprehensive study of specialized literature on the topic of the dissertation, the in-depth analysis and the creative interpretation of the state of the problem are excellent indicators of the doctoral student's high erudition, as well as her knowledge of the essence of the scientific material on the dissertation topic.

4. Contributions of the dissertation work

I accept that the contributions in the dissertation are of a scientific-applied nature, and can be summarized as follows:

1. A comprehensive scheme of tribology as a science and technology has been developed, including the basic contact phenomena, processes, characteristics, applications, and significance for the efficiency and functionality of systems and the environment.
2. New original results have been obtained for the static friction coefficients under sliding and rolling friction conditions in tribosystems containing counterbodies of different types of 3D materials (polymers and composites) using the inclined plane angle tangent method.
3. Precise methodologies have been developed and original results have been obtained for the mechanical properties, microhardness and recovery coefficient of 3D materials (polymers and composites).The methodologies provide a scientifically sound basis for assessing the sustainability and quality of 3D printed samples according to the relevant indicators.
4. Simulation models have been developed in the EDEM Software environment, allowing numerical reproduction of some triboprocesses and validation of the experimental results. The obtained matches with deviations up to 7% prove the applicability of the simulation models for predicting the tribological behavior of 3D printed materials under certain conditions.
5. An innovative application of tribological research to assess the tactile suitability of 3D printed materials as aids for people with visual impairments.

5. Evaluation of dissertation publications

The dissertation presents a list of 7 scientific publications, 5 of which the doctoral student is the lead author. The publications have been reported and printed in

proceedings of authoritative international conferences and in journals indexed in the global database SJR.

The number of publications not only meets, but also exceeds more than twice the minimum requirements for the scientific and educational degree "Doctor".

The high publication activity of the doctoral student as a lead author and in co-authorship is an excellent indicator of the relevance of the scientific problem, the significance of the results obtained, and the personal contribution of the doctoral student under the guidance of her scientific supervisor.

6. Autoreferer

The autoreferer is very well-structured and meets the requirements of the "Act on the Development of the Academic Staff in the Republic of Bulgaria" and the "Regulations for its Implementation" in terms of volume and content. The main activities, the results obtained, conclusions and contributions of the dissertation are reflected.

7. Questions, comments and recommendations

The presented dissertation is completed at a high methodological level and represents a completed scientific work.

I have remarks regarding some inaccuracies that do not diminish the significance of the work, namely:

1. There are some inaccuracies in the list of terms in tribology, for example, for the term under No. 20, p. 11 it is written "anti-wear number", which is incorrect and unclear, probably meaning "class /or index/ of wear resistance". In the term under No. 43, p. 13 it is written that the coefficient of rolling friction is analogous to the coefficient of sliding friction. On the contrary, the coefficient of rolling friction is not analogous to the coefficient of sliding friction. It has a different nature and a different quantitative dimension than that of the coefficient of sliding friction.
2. The dissertation uses methodologies and studies the static coefficient of friction, but this is not specified, and only the concept of "friction coefficient" is used. The static and kinetic coefficients of friction have a different nature, formation mechanisms, different dynamics and depend on different factors. The difference between the values of the two coefficients is the so-called jump of the coefficient of friction, also known in the English-language literature as stick-slip. That is why specifying the concept is of essential importance.

CONCLUSION

The dissertation work presented to me has the volume and qualities of a dissertation work for the award of the educational and scientific degree "DOCTOR" and complies with the requirements of the "Act on the Development of the Academic Staff in the Republic of Bulgaria" and the "Regulations for its Application".

Despite the remarks made, I give a positive assessment of the dissertation work and recommend that the esteemed Scientific Jury award to GABRIELA VIKTOROVA KOCSEVA the educational and scientific degree "DOCTOR" in the scientific field 5. Technical sciences, professional field 5.2. "Electrical engineering, electronics and automation", scientific specialty "Automated information processing and management systems".

НА ОСНОВАНИЕ ЗЗЛД

Sofia, 22.12.2025

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