



REVIEW OF HABILITATION THESIS

Name of the habilitation candidate: **Ing. Milan Uhrčík, PhD.**

The topic of the habilitation thesis: **VPLYV TEPLITNEJ A AMPLITÚDOVEJ ZÁVISLOSTI NA VNÚTORNÉ TLMIENIE VYBRANÝCH ZLIATIN S KUBICKOU A HEXAGONÁLNOU MRIEŽKOU V RÔZNYCH STAVOCH**

Discipline in which the procedure is carried out: **strojárské technológie a materiály**

Name and surname of the reviewer: **dr hab. inż. Marek Roszak, Prof. PŚ**

Place of work of the reviewer: **Department of Engineering and Biomedical Materials, Silesian University of Technology, Poland**

The review was based on the following documents: **habilitation thesis, description of meeting the criteria for the position of assistant professor, list of publications, description of teaching activities, and list of citations.**

This review was prepared on the basis of the letter of the Dean of the Faculty of Mechanical Engineering of the University of Žilina, Prof. Dr. Ing. Milana Sága, number Č.Č.j.: 04668/SjF/2024-pvv of March 25, 2024.

Review of Ing. Milan Uhrčík, PhD's scientific and teaching achievements submitted for evaluation.

1. The topicality of the habilitation thesis topic about the current state of knowledge in the field of engineering technologies and materials

The subject of the habilitation thesis submitted for evaluation concerns issues related to the study of the influence of temperature dependence and vibration amplitude on the internal damping of selected alloys characterized by various internal structures.



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The issue that constitutes the basis of the research carried out in the reviewed habilitation thesis concerns learning about the properties of engineering materials in connection with the impact of vibrations and temperature on them. These issues should be considered current and important for theoretical knowledge of the specific range of properties of engineering materials, as well as practical shaping of their properties in applications when vibrations and temperature significantly impact their wear. The topics covered by the presented research are carried out in various research centres worldwide, including the University of Žilina, which has unique research equipment for conducting research in this field.

The research on the influence of temperature and vibrations on the mechanical properties of engineering materials is not only academically significant but also has practical implications. It is particularly crucial for rapidly evolving areas of engineering activities such as automotive, aviation, and energy. The findings regarding the properties related to internal damping of vibrations of engineering materials can be directly applied in the design of new materials and modification of their production technology to enhance their energy absorption properties in operational conditions.

The type of materials the habilitation candidate tests is an important and constantly developing area of materials engineering. New solutions are being sought to modify their structure to obtain better properties. These rates have a significant share in parts production for the automotive sector. Therefore, the choice of the research subject is correct and valuable from a cognitive point of view. The above allows us to conclude that the research undertaken by the habilitation candidate constitutes a current and important area of scientific knowledge, and the research objectives set in connection with it are part of the ongoing research on understanding the mechanisms of internal damping of materials. Due to the dynamic development of various engineering materials and new areas of their applications, Scientific research in the field that the habilitation candidate has undertaken is fundamental and valuable.



It should be emphasized that the specific operating conditions of engineering materials and their internal structure, determined not only by their chemical composition but also by the conditions of their processing and shaping of properties in technological processes, constitute a significant research area for issues related to the internal damping of materials.

The research presented for evaluation by the habilitation candidate is not an isolated endeavour. It is a continuation of the study by the Department of Engineering Materials of the University of Žilina. This centre has been at the forefront of this research area for many years.

2. Structure and content of habilitation thesis, research methods used

Habilitation thesis by Ing. Milan Uhrčík, PhD., titled: VPLYV TEPLOTNEJ A AMPLITÚDOVEJ ZÁVISLOSTI NA VNÚTORNÉ TLMIENIE VYBRANÝCH ZLIATIN S KUBICKOU A HEXAGONÁLNOU MREŽKOU V RÔZNYCH STAVOCH with number 28230620245001 - University of Žilina, includes the presentation of research results obtained in the field of experimental research work carried out by habilitation candidate in the years 2016 - 2021. The work consists of a monographic study summarizing the experimental research carried out so far. The work has 63 pages and appendices in 11 scientific publications. His share was determined to be from 16.67 to 40%, constituting the basis for the habilitation candidate's monographic study. It should be emphasized that in 8 of the publications indicated, the habilitation candidate was the first author.

The habilitation thesis consists of 5 chapters, which include a presentation of the motivation for undertaking research in the presented scope, a description of the research methodology used, including the characteristics of the research method used by the habilitation candidate, the obtained test results for temperature and amplitude fatigue of selected engineering materials in various states after treatment: plasticizing and heat treatment.



It should be recognized that the structure of the work is classic and correct. It was developed based on 86 cited international, current and closely related scientific publications with the presented topic - including eight sources related to the Department in which the habilitation candidate works and the already mentioned 11 co-authored publications of the habilitation candidate. The publications indicated by the habilitation candidate constitute a collection of results of co-authored experimental research combined with the methodological scope of research on assessing the properties of materials in vibration damping. All indicated publications are in the SCOPUS database and published in renowned international scientific journals.

The attached series of 11 scientific publications on the habilitation candidate is both a supplement to the content and issues described in the monograph to which the habilitation candidate refers and the basis for a monographic study in which the habilitation candidate compiles the obtained research results and makes their overall assessment. Each chapter presents research results and ends with an extensive summary of conclusions from the research.

In the scope of the research, the habilitation candidate used unique research equipment owned by the Faculty of Materials Science and Engineering at the University of Žilina - an experimental research stand for measuring internal damping using the ultrasonic resonance method, designed for uniaxial tension-compression, but also symmetrical bending. The advantage of using this method is its high sensitivity.

Regarding the research methodology used, the habilitation candidate used analytical methods to evaluate the obtained research results and analyze source texts in the area of the analyzed issue. He also used a spectrum of metallurgical research, including scanning microscopy, to assess the obtained structures of the tested materials, including their chemical composition. These methods are appropriate to the scope of the research being conducted.



It should be emphasized, however, that the co-authored articles attached to the monograph contain repetitions; this applies both to the spectrum of unique research methodology (e.g. P7, P8, P10 in terms of the description of the research station, P1, P2, P3 in terms of the shape of the samples and the measurement tool) as well as parts of the test results (e.g. P4 – Fig. 3 and P6 – Fig. 2). The above is an example of the use of unnecessary repetitions in scientific publications, where the author(s) should refer to their previous publications and eliminate unnecessary repetitions.

3. Achieved research results and their contribution to scientific knowledge as well as their importance for engineering practice

The significant contribution of the research submitted for evaluation by the habilitation candidate should be recognised for developing science about materials and manufacturing technologies.

The results obtained as a result of experimental research are of both cognitive and practical importance, expanding knowledge of the properties of the tested materials, but also practical, making it possible to limit the impact of the operating conditions of products made of the tested materials on their fatigue and, consequently, loss of properties.

The selected type of materials is well chosen in terms of their importance in engineering practice. It is worth emphasizing that the research results presented by the habilitation candidate constitute part of the ongoing research projects listed in the study; the habilitation candidate points to 8 projects implemented since 2013 and planned until 2025. The above indicates that research is still being carried out to test the properties of materials in terms of internal vibration damping. I consider the most valuable results obtained in the research to be those relating to the assessment of the properties of the tested materials depending on their processing state (heat treatment, plastic deformation).



4. Characteristics of the habilitation candidate - recognition by the domestic and foreign scientific community, evaluation of teaching work and other activities

Milan Uhrčík is a graduate of the University of Žilina. Since 2013, he has worked as a researcher at the Department of Materials Science and Engineering at the Faculty of Mechanical Engineering. The scope of Mr. Ing. Milan Uhrčík's scientific research concerns issues related to the study of the mechanism and morphology of construction materials cracking for various engineering materials. For years, he has been conducting and improving his research on the temperature and amplitude dependencies of internal damping of materials using specialized research equipment. Regarding his research, he is a well-known scientist in his community and abroad - he cooperates with research centres in Poland and Italy. The scope of the habilitation candidate's publication achievements is primarily related to this topic.

Ing. Milan Uhrčík acted as a supervisor of engineering (2) and master's (4) theses, the subject of which is closely related to the scope of the scientific work and achievements of Mr. Doctor. He reviewed several engineering and master's theses. He is the co-author of two scripts. During his current employment, he taught classes on materials, internal structure and properties of materials, material characteristics, and material selection.

The publication achievements of Dr. Milan Uhrčík include 137 items included in the JCR database as well as WOS, SCOPUS, classified as category A, and over 100 works registered in the WOS, SCOPUS, CC databases, classified as category B. His achievements are significant and present the Doctor's consistent scientific development in his area of scientific interest. This achievement is characterized by 171 citations: an h-index of 7 in the WOS database and an h-index of 8 in the SCOPUS database.



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The Doctor has participated in many scientific conferences, presenting the obtained research results. He is also a reviewer of publications for the MDPI magazine, SEMDOK, TRANSCOM, and Colloquium conference materials.

The Doctor was or is a participant in projects related to teaching and the scientific area that constitutes the scope of his research: he is a co-contractor of educational projects (KEGA) concerning improving the quality of teaching and implementing new methods and innovations in teaching, and he is a co-contractor of several VEGA research projects, APVV, GRANTS, which mainly cover research and applications of experimental approaches and numerical to determine different material properties under different loading conditions. She also provided 26 expert opinions for the industry, which mainly concerned metallographic analyses, spectral analyses, fractographic analyses, microhardness measurements, and explaining the causes of damage to individual elements and parts of machines and structures.

The Doctor also has organizational achievements. He was co-organizer of such international conferences as SEMDOK 2023, SEMDOK 2024, COLLOQUIUM 2022, and Danubia Adria 2015.

She received the Dean of the Faculty's award for her publishing activities in 2020.

He participated in two stays under the Erasmus program - in Germany, in Kleve, at Spectro Analytical Instruments and in Poland, in Gliwice, at the Silesian University of Technology. He also participated in two scientific internships - in Italy at the Polytechnic University of Milan and in Poland, in Gliwice at the Silesian University of Technology.

The above allows us to conclude that the habilitation candidate meets all the requirements for a candidate for the rank of associate professor provided for in the procedure at the University of Žilina.



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5. Comments on the habilitation thesis

During the review of the presented monographic study, I noticed some shortcomings, which I would like to point out to the habilitation candidate so that they can be recognized and used in subsequent research.

In Chapter 4 of the thesis, in the assessment of the structure of the tested material, it was determined that "the AZ91 alloy, which contained a larger share of alloying elements, had a larger share of eutectic and γ phase compared to the AZ31 and AZ61 alloys." – did the habilitation candidate quantify the indicated difference in the scope of the research conducted? What methods should be used to compare the share of eutectics and the resulting phase in the tested materials? I believe such recognition would be significant in assessing the obtained research results for conducting research in this area.

Subsequently, it was also shown that for the tested material, "different aluminium content had a significant impact on the microstructure of the (tested) alloy because with the increase in aluminium content, the interdendritic spaces increased and the amount of eutectic and γ phase increased." – whether in this case the assessment was also made of how much the inter-dendritic spaces and the percentage of the amount of eutectic and the resulting phase increased.

Have any attempts been made to determine the effect of grain size on the internal damping process in the tested materials? The conclusions on page 28 resulting from the research do not provide any characteristic changes in grain size after heat treatment of the tested materials, and this is an essential element of the characteristics of the tested material and the interpretation of the conclusions. Presenting research results in this area and using them to analyze the obtained research results, I believe,

that it would significantly deepen the knowledge of the analyzed relationships.

Also, in the field of austenitic steels tested in the preparation of samples for testing, the statement appears that "recrystallization annealing led to an increase in the grain size in the microstructure

and the removal of most of the deformation martensite." The value of the grain size change and the values regarding the removal of deformation martensite were not given.

In the description of the research results on page 33, the habilitation candidate wrote that "differences in changes in internal damping at individual temperatures are caused by the different presence of alloying elements and carbides." Is this conclusion correct? If so, how should we interpret the so-called different presence of elements and carbides?

I believe it would be extremely important to analyze the issue to research the structure of the tested alloys, revealing any defects in the crystallographic structure - e.g., using observations of the so-called thin foils on an electron microscope, which would provide significant knowledge in the tested alloys.

The above comments regarding the content of the monographic study do not affect the overall positive assessment of the research conducted but only constitute a basis for expanding the spectrum of research.

6. Questions a habilitation candidate should answer when defending his habilitation thesis

a) How was the structure and cross-linking of the tested materials confirmed?

b) Whether the type and number of internal defects in the structure of the tested materials were determined, including, for example, the type of defects in the structure of the crystallographic network. What are the types of defects in the structure of the crystallographic network, and how can they significantly affect the research results? How important are defects in the structure of the crystallographic network for heat treatment and plastic deformation processes?

c) Has the quality of the material been assessed - defects of magnesium alloys obtained during the casting process?



d) Why was the same limiting test temperature of 400°C adopted for magnesium alloys and austenitic steels?

7. Conclusion - recommendation regarding the admission of the habilitation candidate to defense and recommendation regarding the appointment of the candidate to the position of assistant professor

Based on the factual materials presented for evaluation regarding the scientific and pedagogical achievements of Dr. Ing. Milan Uhrčik, I state that:

- the habilitation candidate's achievements are appropriate to the level required to obtain this degree, it is up to date in terms of the importance of the research issues undertaken,
- a significant part of the research results have been published in peer-reviewed international scientific journals, the impact strength measured by publication citations indicates, that the topics and area of research carried out by the habilitation candidate are significant, and the obtained research results constitute an extension of knowledge in the field of materials engineering and technology,
- both the monographic work and the series of scientific publications submitted for assessment indicate good mastery of the ability to present the obtained research results, and understanding of the scientific knowledge of the researched issue, as well as the ability to convey scientific knowledge,
- teaching activities conducted so far, as well as acting as a supervisor of diploma theses, indicate good teaching skills in the field of teaching at a university,
- in the field of scientific research, he is a person with recognized achievements in the scientific community in Slovakia and abroad.



Considering the above, I give a positive opinion on the scientific and didactic achievements of Dr. Ing. Milan Urhicik, PhD., presented for evaluation. I wholeheartedly recommend him as a candidate for further stages of the procedure for obtaining the title of associate professor in Engineering Technologies and Materials at the University of Žilina in Slovakia.

Zabrze, 24.04.2024

Place and date



Reviewer's signature