

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Konstantin Makarenko

PhD Program: Mathematics and Mechanics

Title of Thesis: Microstructural, mechanical, and thermal properties evaluation of functionally graded Fe-Cu structures after direct energy deposition

Supervisor: Associate Professor Igor Shishkovsky

Name of the Reviewer: Prof. Dr. Iulian Antoniac, National University of Science and Technology POLITEHNICA Bucharest, Romania

I confirm the absence of any conflict of interest

(Alternatively, Reviewer can formulate a possible conflict)

Date: 06.11.2023

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

- **Brief evaluation of the thesis quality and overall structure of the dissertation.**

The research presented in this PhD thesis is devoted to the investigation of direct energy deposition of SS 316L – bronze FGMs. It mainly studies their microstructural, mechanical, and thermal characteristics.

Formal quality is good, technical quality is excellent.

The journal publications are of very high to excellent quality with respect to the field.

- **The relevance of the topic of dissertation work to its actual content.**

The thesis is well-structured according to the accepted norms of European scientific research.

The topic of the dissertation is relevant to its content, and the obtained results correspond to their stated applications.

Comments for thesis improvements:

- ✓ The literature review part can be extended with the additional data of mechanical and microstructural characteristics of the DEDed materials of Fe-Cu system.
- ✓ Also, in my opinion, the author of the thesis has to discuss the ternary Fe-Cu-Al system in more detail and compare it better with other ternary Fe-Cu-X systems.
- ✓ Which other properties such as crystal lattice parameters, lattice energy, etc. except of the existence of three stable ternary phases this ternary system is characterized of?
- ✓ Which advantages in the terms of resulting physical characteristics after 3D-printing do these properties lead to?

- **The relevance of the methods used in the dissertation.**

The relevant methods of XRD, EDX, optical microscopy, DSC, DIC, numerical simulation, and others were used while conducting this research. The microstructural characteristics of the materials, the microstructure type and composition were analyzed well and linked to the mechanical properties of the materials correctly.

Minor comments for thesis improvements:

- ✓ I suggest modifying 2.5.5 Tensile testing with digital image correlation analysis in 2.5.5. Digital image correlation (DIC) analysis.
- ✓ Check all subchapters from 2.6. Experimental methods, in order to be similar.
- ✓ The description of methods and equipment can be shortened in chapter 4 of the thesis. Especially, the subchapter 4.4 Crystallization rate and dendritic structure of SS 316L – bronze FGMs. Another solution could be the moved 4.4.1 Relevant Theory. The Diffusion of Elements and the Parameters of Dendrites & 4.4.2 Relevant Theory. The Crystallization Rate at the theoretical part and keep just the 4.4.3 Evaluation and 4.4.4 Summary.

- **The scientific significance of the results obtained and their compliance with the international level and current state of the art.**

The scientific significance of the obtained results is high, and they comply with the international level and the current state of art.

Minor comments for thesis improvements:

- ✓ The spelling and the overall language in the interim conclusions are not excellent and can be revised.

- **The relevance of the obtained results to applications (if applicable).**

The thesis constitutes an important step towards technological applications.

Minor comments for thesis improvements:

- ✓ It is better to specify the temperature ranges of CLTEs in Figure 32.

- ✓ It is recommended to describe the practical significance of the study presented in chapter 8 more clearly. I suggest renaming it as **Personal contribution and future research direction**, due to the relevance of the subchapters 8.1., 8.2., 8.3. for the thesis.
- ✓ Check all the references in order to be similar (e.g. reference 111, reference 121)

- **The quality of publications**

The quality of the related publications is very good.

I would like to specify that the candidate publish some papers as first author in prestigious journals for the field (Q1 and Q2) like Materials & Design, Metals and Materials.

Final remarks:

The presented study meets the PhD requirements and can be accepted for the defense «as is» without any additional corrections.

Provisional Recommendation

I recommend that the candidate should defend the thesis by means of a formal thesis defense

I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report

The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense