Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Biltu Mahato

PhD Program: Mathematics and Mechanics

Title of Thesis: Multifunctional Interleaves for Composite Laminate

Supervisor: Dr. Sergey Abaimov, Skoltech
Co-supervisor: Professor Stepan Lomov, KU Leuven

Name of the Reviewer:

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Signature:**  **Date: 26.12.2023**

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

The thesis is devoted to an important task of improvement of physical properties of polymer composites.

The thesis demonstrates a high quality of research and is well-structured. The abstract provides a clear overview of the research objectives and findings, while the introduction effectively sets the context for the study.

The methods used in the dissertation are highly relevant to address the problem of delamination in fiber reinforced polymer composites. The use of interlaminar region modification methods, such as interleaving polymeric veils and carbon nanotube interleave, shows promise in improving fracture toughness and introducing multifunctionality to the composite laminate.

The obtained results demonstrate scientific significance and align with the international level and current state of the art in the field of fiber reinforced polymer composites. The improvement in fracture toughness, electrical conductivity, and damage sensing capabilities of the laminates through the introduction of carbon nanotubes is in line with current research trends.

The obtained results have direct relevance to practical applications in various industries where fiber reinforced polymer composites are used. The enhanced fracture toughness, electrical conductivity, and damage sensing capabilities of the laminates offer potential for improved structural health monitoring and cure monitoring in composite manufacturing.

Further investigation is needed to understand the optimal concentration of carbon nanotubes in the interleave to achieve the desired balance between fracture toughness improvement and electrical conductivity. The scalability of the proposed methods should be explored to assess their feasibility for large composite structures in industries such as aerospace. Additional validation and testing are required to assess the long-term durability and performance of the modified laminates in real-world applications.

Overall, the thesis presents a strong contribution to the field of fiber reinforced polymer composites, addressing the challenges of delamination and introducing multifunctionality to enhance the properties and functionalities of the laminates.

Some questions and minor comments:

- Pages 21-25: Lists of Figures and Tables should be removed. This is old style.
- Page 29: “Masterbatch is the concentrated form of nanofillers which are produced to ensure that the nanofillers in dry form are mixed uniformly with the polymer and mixing consistency is maintained throughout the material. These masterbatches offer several advantages over the conventional dry form of nanofillers. Some advantages are as; High quality: Masterbatch provides mixing uniformity and consistency, ensuring high-quality dispersion.” – can citations please be provided where a comparison in dispersion degree is shown? Masterbatches generally create areas of high viscosity which are hard agglomerates, how do they help in dispersion?
- Section 3.1, page 83 – why were 0.6% and 7.5% by weight chosen? These values are drastically apart and no background is provided as to their selection. Initial experimentation for the electrospun veils was with MWCNTs, here there is a switch to SWCNTs – why?

- Figure 3.8 – The thickness of the interleaves is much larger than 30 μm from the images. These values should be rechecked in Table 3.5.
- Chapter 3.2.3: how was pressure and heating applied during the curing cycle variation?

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*