Skoltech
Skolkovo Institute of Science and Technology

PhD Defense Jury Member Report

Candidate Name: Oleg V. Lebedev

Doctoral Program: Materials Science and Engineering

Thesis Title: Study of deformational behavior of electrical conductivity of polymer composites with different nanofiller distribution types

Supervisor: Sergey Abaimov

PhD Defense Chair: Alexei Buchachenko   **Email:** a.buchachenko@skoltech.ru

PhD Defense Date: 02.10.2020

Name of Reviewer: Alexey Lyulin

I certify hereby that no conflict of interest (positive or negative) has been identified. *(Otherwise, the reviewer can describe a possible conflict.)*	**Signature:** *(signature)* **Date: 20-07-2020**

Reviewer's Report

The reviewer's report should contain the following items:
• Brief evaluation of the thesis quality and overall structure.
• Consistency between the thesis topic and its actual content.
• Relevancy of the methods used in the thesis research.
• Scientific value of the results obtained and their conformity to the international standard and current state of the art.
• Usability of the obtained results in applications (if relevant.)
• Quality of the publications.
• Summary of the items to be addressed before/during the PhD thesis defense

The PhD Thesis of MSc Oleg Lebedev, "Study of deformational behavior of electrical conductivity of polymer composites with different nanofiller distribution types", covers both experimental and modelling studies of the structure, mechanics and electrical conductivity of some polymer-based nanocomposites, with different nanofillers as, a.o., Carbon Black and MWCNTs. The dissertation possesses all the necessary components, such as a clear Introduction, a comprehensive literature Review, elaborated Results sections that are presented in a logical order, as well as the Conclusions. Overall, the dissertation is

of a good quality. It is well written, and the results are published in (or submitted to) high quality (peer-reviewed) journals in the field. For sure, at my university (TU Eindhoven) this thesis would be admitted to the thesis defense.

The dissertation covers a topic of electroconductive polymer nanocomposites, and presents the results of the different numerical approaches in order to prediction the electrical-conductance response of the material to the applied mechanical deformation. The investigation is conducted for different filler distribution types, such as extreme segregation, the agglomeration, the segregation due to the presence of the insulating fibrous reinforcement. The results presented are, from my point of view, sufficient in order to achieve the dissertation goals.

All the developed experimental and numerical methods are interesting, relevant and novel, solving the set problems with high efficiency, while also providing the necessary information on the investigated subject with sufficient accuracy. The applied multi-scale numerical methods are undoubtfully relevant to the modern direction of research in the field of polymer nanocomposites. The multi-scale modeling approach based on the realistic representation of the filler and its distribution, corresponds to the current state-of-the-art in the field, while experimental verification of the modeling results conforms to the international standards of the non-destructive testing.

The developed multi-scale numerical models could find the practical applications in some industries where workable methods for non-destructive methods are required.

The Thesis results were published in two papers in a high-ranking journal, while the third article was submitted for the publication. All the articles are of high quality.

Before the PhD thesis defense, the following (minor) items are recommended for addressing:

- In the literature review part, some discussion on how the filler aspect ratio and its agglomeration affect the percolation threshold would be desirable;
- In Chapter 3 please add a brief explanation on the reasons behind the decrease of the electrical conductance with deformation;
- In Chapter 4 please add figures depicting the dependencies of the slopes of conductance vs. elongation as a function of the distance from the corresponding percolation threshold;
- The characteristic value (the slope of the conductance-elongation dependency) and the statistical length of a CNT definitions should be added to the relevant pages.

Provisional Recommendation

☒ *I recommend that the candidate defends the thesis by means of the PhD thesis defense.*

☐ *I recommend that the candidate defends the thesis by means of the PhD thesis defense subject to appropriate changes to be introduced in the thesis according to the recommendations of this report.*

☐ *The thesis is not acceptable and I do not recommend that the candidate proceed to the PhD thesis defense.*