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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Oleg Lebedev

PhD Program: Materials Science and Engineering

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

Supervisor: Assistant Professor Sergey Abaimov

Name of the Reviewer: Prof. Dmitry Gorin

I confirm the absence of any conflict of interest	**Signature:**  **Date: 07-09-2020**

Reviewer's Report
The PhD thesis contains 6 Chapters. The first chapter is an introduction, where state of the art in this direction was described in detail as well as main aim of PhD thesis. The main goal of this PhD thesis is providing models for the correlation of electrical properties and applied deformation, considering the structure of materials, and verified by experimental methods. To achieve this goal, the following problems have been solved: 1) analysis and selection of the most suitable types of fillers and methods for their introduction into the polymer matrix; 2) study of the structure and electrical and mechanical properties of composite materials without and during deformation by experimental methods; 3) in silico study of composite structures using experimental data and analytical methods of homogenization to calculate the effective mechanical and electrical properties of composites. Literature review was presented in Chapter 2. Chapter 3 is dedicated to elaboration of computationally effective multi-scale numerical model capable to predict electrical conductance of a thin layer of segregated MWCNTs and its response to uniaxial deformation for modeling of composites with highly segregated 3D structure. Chapter 4 is addressed to the development of numerical methods predicting correlation between deformation and conductance response of composite materials based on PP filled with different concentrations of CB and MWCNTs. Chapter 5 described a model is described that is capable of predicting changes in conductance deformational behavior coming from introduction of reinforcing glass textile into the nanocomposite materials. Chapter 6 contains the conclusions. The bibliography list consists of 102 references. The most important results are the following: deformational response of electrical conductance of composites with segregated structure is highly dependent on how segregation was achieved and what types of components were used; contrast of mechanical properties between insulating regions and

electroconductive phase in composite materials with segregated structure plays a significant role; the transition to the mesoscale leads to decrease of rate of electrical conductance change with deformation.

One of the main possible applications of the PhD thesis results is using of the elaborated numerical approaches for materials prepared by melt mixing method and considering for materials reinforced with fibers that can be used simultaneously as functional and structural.

The obtained results have been published in the three articles. The highest impact factor of journal (International Journal of Engineering Science) is 9.219 (Q1, WOS). The second article published in Journal of Composite Materials (IF=1.972, Q2, WOS). The last one has been accepted for publication in Proceedings of the 36th International Conference of the Polymer Processing Society (PPS). The conference will take place from September 26 to September 30, 2021, in Montreal (Canada).

This work was carried out in the frame of two projects financed by RFBR: 19-03-00369 and 18-33-00688.

It is necessary to consider before the PhD thesis defense the following comments and remarks:

1) It is well known that there are at least two types of CNTS namely CWCNTs and MWCNTs.

I didn't find explanation for choice of MWCNTs as a model filler in the PhD thesis;

2) page 34, line 2 from top, What does symbol"%" after "polymer matrix" mean?

3) page 37, Figure1, Figure 1 (a) and (c) – absence of scale bars;

4) page 59, Figure 11, Figure 11 (c) - absence of scale bar value;

5) page 72, Figure 18, Figure 18 (b) – absence of scale bar;

6) page 72, 4.2.2. Experimental methods – I don't find current voltage characteristic of measured structure. These data are required for confirmation that there are ohmic contacts. The photos of experimental setup as well as measured samples would be also useful.

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*