

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Ilya Novikov

PhD Program: Materials Science and Engineering

Title of Thesis: Assembling networks of single-walled carbon nanotubes for electronic and optical applications

Supervisor: Professor Albert Nasibulin, Skoltech

Co-supervisors:

Professor Tanja Kallio, Aalto University

Assistant Professor Dmitry Krasnikov, Skoltech

Assistant Professor Fedor Fedorov, Skoltech

Name of the Reviewer:

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	Date: 03-09-2023
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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

In the thesis of Ilya Novikov, he investigated the SWCNTs based nanomaterials and their electronic and optical applications. This thesis mainly includes two parts of research works. This first one is to synthesize the transparent conductive SWCNT films by CVD method and analyze the physical properties of the as-prepared SWCNT films. For the second part work, the author prepared the conductive SWCNT/polymer composites by the coprecipitation of SWCNTs and TPU in water, which obtained the composites with the ultralow percolation threshold (0.006%). The thesis is well organized and the conclusions are well supported the data. Up to now, Ilya Novikov has published two high-quality papers as the first author in doctoral period.

Some comments or questions:

1. There are still some grammatical or format errors in the thesis. For example, in page 3 (Abstract), the sentence “Reactor chemical engineering approaches **were developed**: controllable adjustment of residence time (τ , by flow rate control) **allows** maintaining catalyst activation stage and varying nanotube growth, this way optimizing $R90$ ($51 \Omega/\square$ was achieved for doped films) (i), and the introduction of H_2 as a reducing agent, which **was demonstrated** to increase synthesis yield by 15 times (ii).”, the forms of the tenses in this sentence is not consistent. In addition, “ Ω/\square ” is not correct.

In page 99, the sentence of “Besides, magnified SEM images (**Figure 18c1-d1**) illustrate the gradual thickening of bundles approaching the TPU matrix, **which** might indicate high TPU wetting of nanotubes, **which** is attributed to the high affinity of TPU to nanotubes and is in a good agreement with the reported data [167,168].” is not correct from its structure.

In page 107-108, “powders (Table 1)” is dissected into two pages.

In page 108-109, “magnitude (Table 1)” is dissected into two pages.

In page 106, the title “5.2. SWCNT/thermoset nanocomposites. Nanotube bulk density optimization.” is not suitable. It seems there are two sentences for one title.

2. Did the author make modification of the commercial SWCNTs for the section of SWCNTs/polymer composites? It seems there are good compatibility between SWCNTs and polymer matrix. Why?

3. For SWCNTs/polymer composites, there show ultralow percolation thresholds based on the curves of Dc conductivity plotted versus SWCNT concentration. What is the volume fraction of

SWCNTs in polymer matrix? Since here the composites are prepared by the coprecipitation of SWCNTs and TPU in water. SWCNTs should be randomly distributed in TPU matrix. Therefore, SWCNTs can only form a random conductive network in TPU. It is strange that SWCNTs can form the percolated network at a concentration of 0.006%.

4. For the strain sensing properties of SWCNT/TPU composites, how about their stability and repeatability? Since SWCNTs are high aspect ratio and rigid, the conductive SWCNTs networks can not be completely recovered after stretching.

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