Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Hassaan Ahmad Butt

PhD Program: Materials Science and Engineering

Title of Thesis: Hybrid functional materials based on single-walled carbon nanotubes

Supervisor: Professor Albert Nasibulin
Co-supervisor: Assistant Professor Dmitry V. Krasnikov

Name of the Reviewer: Yulia V. Ioni

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Date: 22-11-2023**

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

The PhD Thesis work submitted by Hassaan Ahmad Butt for review is focused on developing a method of monitoring carbon nanotube polymer nanocomposites using carbon nanotube fibers. The thesis is devoted to the reconnaissance study of how CNTFs may be integrated with multifunctional CNT nanocomposites for their *in situ* monitoring. The thesis involves the use of techniques which are applicable at a laboratory scale, with the possibility of pilot and industrial up-scaling.

Overall, the quality and structure of the PhD thesis work look acceptable and logical. The work is organized in an easy-to-follow manner and addresses major aspects related to the problem. The thesis is divided into 5 Chapters which are sufficiently connected to each other and cites relevant and recent works. The topic of the Thesis is well explained and adequate to the work conducted. The methodology for obtaining new materials based on SWCNTs described in the work as well as the materials and methods used meet the high requirements of international standards. It is worth to note that the conclusions of the work are logical and well formulated. Summarizing, the work meets the requirements for a PhD Thesis and follows international standards, which is proven by the two published papers and two manuscripts submitted for publication in the highly rated international journals. The work may be considered as contributing added value to the field of study since it discovers a novel material application and findings.

The thesis, in its current form, may benefit from answering the following comments and questions:

1. How was the selection of CNT film widths grounded?

2. Why was the twisting selected as the densification method?

3. The work contains some errors and inaccuracies. For example, in the list of references in reference 10 there is an error in the word “filaments”, in reference 44 a space is missing, some references do not contain complete output data (pages are missing). There are some problems with abbreviations in the text, for example, there is no definition of the abbreviation UTS, DIC, and, on the contrary, the abbreviation STEM does not appear in the text. Also, the author should capitalize the term “Young’s modulus” (p. 15), the name of the Keithey multimeter and Intron 5969 instruments (p. 46). On the page 51 the end of the last sentence is missing and on the page 82 the author has an error in the text ("Fig. 1").

4. Figure 9 shows SEM images of three SWCNT powders of different types (briquette, pristine, RESS), but there is no SEM image of the masterbatch.

5. What is the reproducibility of the technique used for producing composites with different wt% content of single-walled carbon nanotubes?

6. The work should provide standards that define the upper limit for cyclic testing of polymers.

7. Please explain the choice of composites with 0.25 and 0.75% by weight for subsequent multifunctional property monitoring?

8. The figure on page 53 is numbered incorrectly. Also, Figures 19 - 21 should be changed because they are presented in low quality: the scale along the y-axis is incorrectly selected, the captions are in small font. Figure 28 should be also changed. The 2-point electrical measurements curves for the MWCNT and SWCNT nanocomposite are highly noisy, please explain the reason. Were the experiments carried out at the same time? Please describe the external conditions?

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*