

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Maria Zhilyaeva

PhD Program: Materials Science and Engineering

Title of Thesis: A novel straightforward wet pulling technique to fabricate carbon nanotube fibers

Supervisor: Professor Albert Nasibulin

Name of the Reviewer: Tanja Kallio

I confirm the absence of any conflict of interest	
(Alternatively, Reviewer can formulate a possible conflict)	Date: 22.10.2021

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 presented Doctoral Thesis “A novel straightforward wet pulling technique to fabricate carbon nanotube fibers” by Mariia Zhiliaeva is devoted to a newly invented method of carbon nanotube (CNT) fiber manufacturing. The work describes so-called wet pulling technique and investigates characteristics and applications of the obtained CNT fibers. The developed fabrication method allows straightforward fiber production out of CNT thin films, which are collected on a filter after the synthesis. The method relies on a combination of CNT film and solvent properties.

Mariia Zhiliaeva’s thesis studies practically a very important task in materials science due to the growing demand for wearable electronics, which require flexible and stretchable conductive materials. The developed wet pulling technique has prominent advantages which make it a promising candidate for both small and large-scale production of CNT fibers with desired properties. The method is also easily adaptive to different kinds of CNTs and allows rapid fabrication of both active and passive flexible electronic components.

The thesis consists of six chapters set forth on 90 pages. Below are some comments and questions that arose after careful thesis examination:

- Chapter 3.1 describes wet pulling technique applied to randomly oriented SWCNT and CNT dispersion. Details on the fibers made of aligned CNTs are missing. Would the fibers' characteristics stay the same if they would be made of aligned CNTs films? Would it be possible to make the same devices based on them?
- Figure 7, Chapter 3.1.3 describes a potential large-scale production line. Chapter 2.2 describes using solvent and dopants during the wet pulling procedure (WP) to enhance fibers properties. Can they be applied during this roll-to-roll manufacturing process?
- Chapter 3.3.1 describes PDMS encapsulation. Which other materials can be used for encapsulating WP CNT fibers?
- Chapter 3.4 describes impressive applications, including a tunable force range sensor. What are the actual boundaries for the applied force measurements?
- Chapter 3.4.4 describes a nanophone device based on the WP fibers. Figure 29 shows the PDMS encapsulated fiber, which is in direct contact with the speaker. Can the nanophone record the sound waves remotely in environments other than air?

The dissertation is based on two co-authored publications and one submitted manuscript, in two of them, Mariia Zhiliaeva contributes as the first author. The papers are published in international peer reviewed journals; for the published studies these include Carbon (IF=9.6) and Materials Science and Engineering B: Solid-State Materials for Advanced Technology (IF=4.0). The manuscript is submitted to Soft Robotics (IF=8.0). The number and level of publications as well as the position of the PhD candidate in the co-author’s list apparently show her sufficient contribution to the research field.

In general, the contribution of Mariia Zhiliaeva to the field of material science and engineering is important and substantial. The dissertation is written in a very good scientific language. Mariia carried out most of the work, her dissertation studies contributed to fundamental understanding. Given that the submitted manuscript will be published, she has a sufficient number of scientific publications on the topic of her dissertation. Mariia Zhiliaeva’s dissertation is an original work possessing fundamental novelty and practical importance alike. I strongly recommend awarding a PhD degree to the author of the thesis. The PhD thesis manuscript can be accepted for publication as a doctoral dissertation after minor changes and candidate should defend the thesis by means of a formal thesis defense.

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