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# Jury Member Report – Doctor of Philosophy thesis.

**Name of Candidate:** Javier Antonio Ramirez Benavides

**PhD Program:** Materials Science and Engineering

**Title of Thesis:** Advanced single-walled carbon nanotube membranes for optoelectromechanical applications

**Supervisor**: Professor Albert Nasibulin

**Co-supervisor**: Assistant Professor Dmitry Krasnikov

**Name of the Reviewer: Yulia Ioni**

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| I confirm the absence of any conflict of interest | **Date: 28-10-2024** |

*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 Javier Antonio Ramirez Benavides for review appears to be well-structured, following a standard scientific dissertation format. It includes an abstract, thesis publications, acknowledgements, table of contents, and multiple chapters covering literature review, experimental methods, results and discussion, and conclusions. This structure suggests a comprehensive and organized approach to presenting the research. The work focuses on advanced single-walled carbon nanotube (SWCNT) membranes for optoelectromechanical applications, which aligns well with the content presented. The Thesis aims to develop methods for modifying SWCNT free-standing films for specific applications.

The Thesis describes CVD aerosol synthesis to obtain high-quality SWCNT-based free-standing films, followed by the development of treatment methods to achieve specific goals, such as evaporating Sn particles and enhancing mechanical and electrical properties of materials. The thesis has resulted in multiple publications in respected journals such as Carbon and Applied Physics Letters, as well as a patent. This indicates that the research has undergone peer review and is of sufficient quality to meet international publication standards. The developed SWCNT membranes have potential uses in EUV lithography, aerosol filtration, and as transparent electrodes for various devices such as bolometers, supercapacitors, flexible electronics, and solar cells.

Overall, the PhD Thesis of Javier Antonio Ramirez Benavides appears to be of high quality, addressing relevant scientific and technological challenges in the field of carbon nanotube applications. Some comments and questions regarding the text of the work are given below.

1. The text contains a large number of syntax errors (extra spaces, paragraph breaks, and missing punctuation marks), and in some places it is difficult to read. The figure captions are not consistent, namely, after “Figure No” there is either a colon, a period, or there are no any punctuation marks. The term “Joule heating” sometimes written with a lowercase letter.

2. The list of abbreviations should be supplemented with abbreviations present in the text: PTFE, MCD, HEPA. Abbreviations should be used consistently. The text sometimes contains chemical vapor deposition, sometimes CVD; sometimes ultraviolet, sometimes UV, *etc.* Also, multiple abbreviations should be removed from the text (for example, on page 60 – DC).

3. Please, indicate the country of manufacturer for the SEM, TEM, EDX equipment in the experimental section.

4. Page 27: is it important to write 2000 µm, or can they be corrected to 2 mm without losing the meaning?

5. In the text, the author sometimes describes the conducted research too emotionally: “I observe…”. There are accepted impersonal canons for writing scientific texts; please, correct the text accordingly.

6. It is advised to propose the future potential directions for this research, including any limitations that need to be overcome.

Some specific comments related to representation of the results in Figures:

- The designation of carbon structures F-H is missing in Figure 1.

- Figure 8 is not a Schematic description of synthesis of vertically aligned carbon nanotube forest.

- If the figure is designated as a Scheme, then the designations of the main elements (equipment) should be added to it. This applies to Figures 20 and 33.

- Page 86: separate the name of the Institute of Spectroscopy from Figure 38. On page 89, please remove the phrase in brackets, it is redundant. The legend in Figure 40 should be changed.

- Page 90: at the bottom, when discussing Figure 41, there is an error: images C and D are missing. In general, the results of electron microscopy discussed in a very chaotic manner, with no system.

- Page 94: the results of Raman spectroscopy are discussed (Fig. 43). However, Fig. 43A shows the UV spectra of the materials.

- Ultimate tensile strength (page 100) is measured in kPa. In the figure, correct 3x10 -1 Pa.

**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*