Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Yuliya Kan

PhD Program: Materials Science and Engineering

Title of Thesis: Development of core-shell fiber composite based on polyvinyl alcohol modified with graphene oxide and silica for biomedical applications

Supervisor: Professor Alexander Korsunsky
Co-supervisor: Professor Keith Stevenson

Name of the Reviewer: Elia Marin

I confirm the absence of any conflict of interest	**Date: 08-12-2022**

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

Summary evaluation

The thesis from the candidate PhD student Yuliya Kan is adequate in both form and structure. The contents are interesting and well in line with recent literature in this field. Results, images and tables are meaningful and well organized. The references used are relevant and reasonably recent.

Relevance of the topic

The scientific interest for electrospinning has been constantly growing in the last decade, in particular for biocompatible materials to be used as scaffolds for tissue engineering and regeneration. The candidate developed innovative core-shell fibers based on polyvinyl alcohol modified with graphene oxide and silica, using state-of-the-art technological approaches. In this sense, the work of PhD student Yuliya Kan is not just relevant to the scientific community, but also has potential for a future industrial scale-up, even if it still presents a few technical difficulties. The characterization techniques used and the amount of results achieved also represent a good starting point for future developments in this line of research.

Methods

The candidate used modern production methods and a wide array of characterization techniques. In particular:

- A state of the art custom made electrospinning setup was used for the production of the coaxial fibers;
- The solutions were tested for their viscosity and electrical conductivity;
- Fiber mats were tested for their contact angle, morphology, chemical composition, thermal and mechanical properties.

The sample preparation procedures and the characterization techniques used are adequate for the materials and could give a complete characterization of all the key technological properties of the composites.

As a minus point, since the samples are intended for biomedical applications, *in vitro* testing could have provided additional information on the biocompatibility (cytotoxicity in particular) of the composites and their resistance to bacteria adhesion and proliferation. These tests could have further strengthened the thesis significance.

Scientific significance

The work of Yuliya Kan is innovative, as results on coaxial fibers obtained by using PVA and graphene and silica were never published before. Moreover, the technological approach for the production of coaxial fibers is still relatively new, making the thesis a step forward in the understanding of coaxial electrospinning and, in particular, composite electrospinning based on ceramic particulates. Both silica and graphene oxide have seen previous biological applications, in particular when functionalized or used in drug delivery applications.

In this thesis, the latter approach was preferred as the fibers were tested for their pharmacokinetics, showing potential for *in vivo* applications.

The thesis has both novelty and significance.

Relevance to applications

Controlled drug delivery is one of the main research topics in the field of biomaterial science. The coaxial composite technology proposed by Yuliya Kan represents an innovation when compared to conventional coaxial electrospinning, as the drug release over time (as well as the dissolution of the polymeric matrix) can be controlled by the particulate fractions and not just by the molecular weight of the polymer itself.

Quality of the publications

The candidate presented 5 research papers and 3 conferences as her PhD activities. All 5 publications see her as first author and 3 out of 5 are on peer reviewed journals with impact factor and/or SJR ranking. The highest impact factor is 4.9 and the lowest 3.7. She received a total of 29 citations in her career and reached an h-index of 4. Her total number of publications, according to Scopus, is 11, of which 5 see her as first author.

The number and quality of the presented documents is adequate for a PhD candidate, while her role as first author indicates the candidate actively contributed to the projects. The published materials show that the candidate's research is broad, but without sacrificing accuracy and meaningfulness.

Comments on the thesis

Title: I suggest to use either "a core-shell fiber composite" or "core-shell fiber;

Abstract: the abstract is concise and clear, containing all the necessary information;

Introduction and literature review: the contents are meaningful and follow a clear logic;

Experimental procedures: clear and easy to understand

Results:

- Table I doesn't show any statistical dispersion of the data, moreover the number of significant digits should be consistent (10.0, 8.4, 8.4, 9.0, using the second column as an example);
- Figure 9(c): the water uptake doesn't present a statistical dispersion;
- The discussion on the Raman results is hard to follow as only 3 bands have been clearly labelled in Fig. 10. Please consider tagging all the major bands;
- In Fig. 10 how can you tell there is a CHX band at 1600 when the G band is exactly at the same position?
- Raman bands for SiO2 are usually very weak. In this case, I can't really spot them in the fiber results;
- Figure 11 has more labels, but the labelling method is inconsistent: some samples are labelled with band positions, others are labelled with vibrations and sometimes there in no label at all;
- Please note that the x axis labels of Fig. 11a re cut suddenly;
- The FTIR spectra are very similar to each other so differences are hard to spot. Please clearly mark what the readers should focus on;
- As for Raman and FTIR, XRD bands should also be labelled clearly;
- Again, Table 8 and Table 9 will require some statistics;

- The international separator for decimals is ".". I don't know if the same standard applies in this case, but please confirm;
- From Figure 20, the results are interesting but I can't really trust the trends without some solid statistics, as these materials tend to have a wide dispersion in loading efficiency and release, due to problems in uniformity and distribution;
- At the end of this section, a short comparison with literature data could be an interesting addition, to understand if these mats behave better or worse than those developed by other research groups. A little more focus on the potential application (which could be the best way to use these materials?) would greatly improve the quality of the thesis, with only a little effort.

Provisional Recommendation

I recommend that the candidate should defend the thesis by means of a formal thesis defense