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# Jury Member Report – Doctor of Philosophy thesis.

**Name of Candidate:** Anastasiia Merdalimova

**PhD Program:** Physics

**Title of Thesis:** Optical Sensors Based on Hollow-Core Microstructured Optical Waveguides: 2-in-1 multispectral refractometry and Raman spectroscopy

**Supervisor**: Professor Dmitry Gorin
**Co-supervisor:** Associate Professor Alexey Yashchenok

**Name of the Reviewer: Vladimir P. Drachev**

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|---|---|
| I confirm the absence of any conflict of interest.<br><br>(Alternatively, Reviewer can formulate a possible conflict) | **Date: 17-11-2023** |

*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

- Brief evaluation of the thesis quality and overall structure of the dissertation.

  The thesis studies relatively new substrate for biosensors, hollow-core microstructured optical waveguides (hc-mow). The PhD candidate with co-authors conducted interesting research on hc-mow use for Raman scattering, SERS, and refractive index-based detection. Experimental work is well thought out.
  Speaking of the thesis presentation, there are some sloppy moments, which require author's attention. All the issues are commented below.

- The relevance of the topic of dissertation work to its actual content.

  -The topic of the dissertation is in correspondence with its actual content.
- The relevance of the methods used in the dissertation.

  -The methods used in the dissertation are adequate to the goals of work.
- The scientific significance of the results obtained and their compliance with the international level and current state of the art.

  -The results sound significant while not always expected.
- The relevance of the obtained results to applications (if applicable).

  -The obtained results focus on the molecular sensors. An initial step towards applications is taken using well known model analytes like Rh6G and BSA.
- The quality of publications.

  -The quality of publications by the thesis author are appropriate to the PhD defense.

The summary of issues to be addressed before/during the thesis defense:

1.The thesis contains 58 pages of introduction and literature overview out of 111 pages.

Such a proportion for dissertation sounds overlarge towards introduction and literature.

2.Method of RI measurements should be fully presented in the methodology section 3 instead of literature overview. It should be discussed whether RI calibration for a certain analyte can be universal.

3.Final statement: "The developed sensing methods show promise for real-time detection of small quantities of biological markers, making them valuable for rapid diagnostics."

What does it mean real-time detection? Which biomarkers are meant?

4.Table 7-1 is missing

5.Fig 7-7 captions do not correspond to the figs.

6.I am confused with the section 7-2-3 and Fig 7-9.

"Raman spectra of EV and controls, measured in HC-MOW, are demonstrated in Figure 7-9. Despite the long signal acquisition time (90 or 120 s), no significant EV spectra [216,219] (proteins and lipids, which are the main components of EV) were detected, and the observed Raman peaks belong to polypropylene [232], the material of the tube."

The results in Fig.7-9 should be presented in details or removed.

7.Where is Table 1S, Table S1?

8.What is the Ref. 26? 26. Merdalimova, A.; Barmin, R.; Vorobev, V.; Terentyeva, D.; German, S.; Chernyshev, V.; Maslov, O.; Skibina, Y. Two − in − One Sensor of Refractive Index and Raman Scattering Using Hollow − Core Microstructured Optical Fibers for Colloid Characterization. 1–32.
9.Table 4-1. Raman peaks assignment for BSA monocomponent solution.
The BSA peak 1004 см-1 should be assigned to the ring breathing mode of Phe.
10."Figure 4-3. BSA monocomponent solution Raman spectroscopy measurements: (a) in HC-MOW, (b) in a bulk solution, (c) in a drop on a planar substrate. Reproduced with adjustments from [26]"
The caption does not correspond to the panels.
11.Two key technologies should be described in correspondence with done experiments even accompanied by the references. The thesis use "Figure 5-4. The fabrication process of SERS-active HC-MOWs with SEM images incorporated. Reproduced from [1].
Figure 5-6. Raman and SERS of R6G in HC-MOW: 1 – bare HC-MOW; 2 – HC-MOW with UV-Trans chloroauric acid reduction on gold seeds. Reproduced from [1]"
The key features of the hollow fiber, what is the fiber variations, does it correspond to the used one.
12.Transmission/absorption spectra of the SERS substrates are important when one compares the Raman results for them
13.Question regarding the fiber enhancement for BSA, does it take into account change in the transmission spectra?
14.What is the optimal transmission of the hc-mow for Raman? Minima or maxima?

**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*