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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Timur Ermatov

PhD Program: Physics

Title of Thesis: Optical properties of hollow-core microstructured fibers modified by polymers and/or inorganic nano- and submicron particles

Supervisor: Professor Dmitry Gorin

Name of the Reviewer: Andrei V. Zvyagin, Macquarie University, Sydney, Australia

I confirm the absence of any conflict of interest	**Date: 28-09-2021**

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

I examined PhD thesis "Optical properties of hollow-core microstructured fibers modified by polymers and/or inorganic nano- and submicron particles" by the candidate Mr Timur Ermatov. This thesis addresses an important problem of the application of microstructured fibres and photonic crystals for determination of refractive indices of liquids, including biological fluids. This research topic is hot because it responds to the need of rapid in-line sensing relying on accurate determination of the refractive index of analytes. The reported approach is proven superior to conventional Abbe refractometers in terms of versatility and application scope. The top result in my opinion is presented in Chapter 7 describing in-fibre multispectral optical sensing. This result has been reported in a premier journal in optics, Light: Science and Applications, and I believe this result is truly impressive. The candidate and co-authors have demonstrated determination of the refractive index of albumin, which was elusive due to its high sensitivity to solvents and physiological conditions. The introduced microstructured optical fibre (MOF) technique enabled these measurements alongside with the determination of the refractive index dispersion across the broad visible and near-infrared spectral range. This top result was prepared step-by-step, first, by careful characterisation of MOF devices modified by polyelectrolyte coating of their inner surfaces and testing their accuracy and reproducibility. The reported experimental techniques and methods for the functionalisation of MOFs with submicron and nanoscale particles to endow extra sensitivity to liquids and gases is worthwhile.

This thesis is well structured and written in clear concise language with appropriate number of schematic diagrams and graphical result presentations. The thesis introductory part contains comprehensive account of the state-of-the-art of the field, including optical fibres, MOFs and hollow fibers functionalisation approaches. The results are competitive at the international level, published in credible optics journals, such as "*Light: Science and Applications*", "*Optics Letters*" and "*Optics Express*".

I have no doubts that the candidate Mr Timur Ermatov deserves a PhD degree based on my examination of his PhD work. I suggest the following changes to the existing version of his thesis, which are optional and up to the candidate to implement:

1. Could the author provide more examples of the existing point-of-care devices based on optical fibres and discuss their pro-s and con-s?
2. Referring to Fig. 4-8, where the key results of the humidity measurements are presented, discussion of these results is largely missing. I suggest the candidate to provide a brief summary of the main findings, as well as the key merits and liminations of the reported technique for high-sensitivity sensing.
3. Does the reported approach allow decoupling the refractive index and thickness of the deposited layer?
4. How was the surface concentration of silica particles measured? Figs. 3.8-3.11.
5. Fig. 3-20 quality is poor, please replace.
6. Fig. 3.8. The surface is ostensibly rough when coated with silica sub-micron particles, although the candidate infers best surface quality from these images. Is it based on SEM images or other observations?
7. I am curious what the speed of water through the smallest capillaries was to cause the deposition of 900-nm beads on the rear surface of the capillaries?
8. All the studies were performed based on 6-cm long fibres; can the functionalisation techniques reported in the thesis be also used to modify longer sections?
9. The transmission peaks and troughs are mostly periodic versus e.g. layer thickness. Does it cause problems with unwrapping.
10. The conclusion and future work can be more elaborated.

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*