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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Igor Salimon

PhD Program: Physics

Title of Thesis: Laser synthesis and modification of nanomaterials

Supervisor: Assistant Professor Sakellaris Mailis

Name of the Reviewer:

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Date: 02-10-2023**

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

The thesis by Igor Salimon after reading leaves a good impression. In my view, the sequence of chapters with content was carefully thought out, all relevant main results have been published in peer-reviewed journals and some additional will be definitely published. The work performed by I. Salimon during his PhD program and presented in his thesis is at high level of international science. Therefore, I have no doubts that Igor should get PhD degree in Physics. However, as most of the works this thesis is not ideal and I would like to bring to Igor's attention some comments and/or suggestions.

1) The title is extremely broad. Usually, such title is expected when you are reading classical table books or check the scope of prestigious international conference. The results presented in the thesis definitely do not cover such broad field of science, but match precisely in terms of scale to three (or four?) publications. These nice works are thematically well divided into chapters and therefore, I would recommend to "narrow" the title and make it more specific.

As an example, one of the main results seems to be very specific: "In this work, we observed formation of LSFL-II on transitional metal dichalcogenides (TMDCs) during synthesis from insulating films of ammonium

tetrathiomolybdate ((NH4)2MoS4) deposited on a layer of silica on silicon wafers and formation of LSFL-II on GaAs crystals"

2) Too general and vague wording is used in the abstract and the introductory sections of the text.

Just few examples below:

-(from Abstract) "Discoveries in novel materials (namely, 2D materials) and characterization techniques call to revisit laser writing in terms of overall research flow..." Here, both novel materials and especially 2D materials are so wide terms, used in different context by specialists working in different fields.

-(from Abstract) "This research was aimed at understanding of some aspects of material modification and reorganization into new structures under pulsed laser scanning..."

In my view, understanding "some aspects of material modification" should be replaced with precise description of the research directions pursued by Igor and his colleagues. Otherwise, such sentences (even though introductory) carry zero information for the readers.

-(p.4, Abstract) "For higher fluences, self-assembled conical structures are formed, reaching heights of 30 μm." It would be good to understand what is meant here with "higher" (higher than what? or please provide the reader with some numbers).

-(p.20, Ch.1) "Lasers are widely used in industrial material processing [1]. Compared to other methods of material processing, they possess several key benefits".

The thesis would benefit from indicating existing these "other methods of materials processing."

-(p.21) "A sufficiently short pulse excites a large amount of electrons at time scales much shorter than those required to heat up the ion lattice."

What is this time? How the time scale changes when matter changes (I believe this time should be indicated at least for the type of materials investigated here - GaAs, 2D TMDCs)

-(p.28) "By using pulsed irradiation, it is easier to reach peak beam intensities that surpass energy thresholds needed to ablate, melt or oxidize the material."

Please provide these numbers or range of numbers.

3) In my view the Introduction section lacks underlying physics and phenomena which would be beneficial to expand for the main results description. At the same time extreme attention is paid to technical description of used techniques and instruments.

Let me give some examples: p.23, section 1.3, introduction to LIPSS. According to the dissertation, the LIPSS is known for 6 decades and has been observed in numerous materials. This hints us that the mechanism is well understood and as a reader I expected to see the description, however, Igor first mentions classification of the LIPSS (1.3.1) and then proceeds with the applications (1.3.2), leaving overboard the mechanism itself and physics around, which is partially covered next in 1.3.3.

"...the formation of LIPSS is attributed to the interference between the incident field and a scattered optical field arising from surface roughness [41]. This interference results in a periodic modulation of the intensity distribution on the surface, which leads to a periodically modulated deposition of energy." Here

the question immediately arises whether LIPSS is possible in polished samples? In other words, I would recommend reorganize these sections and some text to make it more transparent for the reader.

4) General note on low quality of Figures reproduced from other works (as an example, Fig3 at p.39). Another thing is their high fraction compared to original number of figures made by Igor for the thesis. This is, of course, minor comment and not about the physics.

5) I would like to pay attention to personal contribution sections. It is good and actually essential to acknowledge all the work done by Igor's colleagues. However, the way how it is currently presented leaves an impression that personal contribution of Igor is relatively small (which I am sure is a wrong). See as an example p.42-43, p.82.

Therefore, I would recommend to focus (in text) mostly on the results obtained by Igor, though I perfectly understand that scientific work is often a team work. Otherwise, I have a question regarding leading role of candidate in publication #4: Averchenko AV, Salimon IA, Zharkova EV, Lipovskikh S, Somov P, Abbas OA, Lagoudakis PG, Mailis S. Laser-enabled localized synthesis of Mo1-xWxS2 alloys with tunable composition. Materials Today Advances. 2023 Jan;17:100351. As far as I know, this work is going to be used for Phd defense by A. Averchenko as well.

To sum up, I believe that presented results and achievements of Igor Salimon are substantial for PhD degree. I think that Igor has demonstrated his knowledge and expertise, however, I hope to see some corrections in the text. All of the above comments do not detract from the merits of the work done.

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*