

## Jury Member Report – Doctor of Philosophy thesis.

**Name of Candidate:** Anton Baranikov


**PhD Program:** Physics

**Title of Thesis:** Dynamic polariton condensation in organic microcavities

**Supervisor:** Prof. Pavlos Lagoudakis

**Date of Thesis Defense:** 8 November 2019

**Name of the Reviewer:** Prof. Dmitry Gorin

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| <p>I confirm the absence of any conflict of interest</p> <p>(Alternatively, Reviewer can formulate a possible conflict)</p> | <p><b>Signature:</b></p>  <p><b>Date: 07-09-2019</b></p> |
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### Reviewer's Report

The PhD thesis contains 6 Chapters. The introduction describes the historical facts and partly state of the art related to the topic of the PhD study and formulates the main goal of the PhD thesis. The main goal of the PhD thesis has been obtained as results of the solution of tasks in the following directions: 1) experimental realization of vibron-assisted polariton condensation in organic microcavities; 2) experimental realization of "on-demand" polariton condensation driven by the second optical probe beam; 3) demonstrate polariton amplification based on the polariton condensation; 4) investigate switching behavior and experimentally test the cascability of amplification. Chapter 2 presents an introduction to the polaritons and a short review in the field of investigation of the PhD thesis. It is also described that organic semiconductors have numerous advantages in comparison with inorganic ones, including large binding energy. The disadvantages of organic microcavities have also been covered in the details. Chapter 3 is dedicated to polariton condensation in an organic strongly-coupled microcavity. There is an introduction to organic microcavities as well as the experimental details on the samples, the excitation and detection schemes, and also the data of the experimental results with discussions. Chapter 4 is addressed to the polariton amplification. Chapter 5 is related to all-optical polariton logic. This chapter is the most interesting from the point of view of applications for optical-based logic. Chapter 6 contains the conclusions as well as the author's vision of future research. The bibliography list consists of only 68 references. The quality of writing and print design is very high. The author uses the LATEX for thesis processing.

The most important results can be divided into three groups. The first is a realization of vibron-mediated polariton condensation at room temperature. The second is a realization of polariton amplification driven by bosonic stimulation and vibron-mediated relaxation at room temperature. The third is a demonstration of the switching concept, the cascable operation, and the principles of AND and OR logic gates. The last result has a very promising perspective for applications in the future. This PhD thesis is an example of a

unique combination of complex experimental setup and realization of functional applications. One of the possible applications of the PhD thesis results is a realization of THz optical switching.

One of the main results of PhD thesis has been published in the international journals with a high impact factor (IF) named Nature Photonics (IF= 31.583) and Polyhedron (IF=2.284). The other one is under revision in the new journal of Nature publishing group named Communications Physics. The quality of the publications is very high and has been confirmed by IF of the journals. The contribution of the author in the articles are described in the detail. The affiliations of the co-authors, as well as the level of the journals and references, show the international level of the PhD thesis results.

It is necessary to consider before the PhD thesis defense the following comments and remarks: 1) page 43. 2.2.3 Inorganic vs organic. It could be useful to give the comparison of inorganic vs organic in the table where disadvantages and advantages organic and inorganic materials will be presented; 2) a summary after every chapter including the review would be very useful; 3) the bibliography list contains only 68 references. It could be useful to increase the number of references; 4) page 41, Fig.3.1, please add information about the thickness per every layer; 4) page 81, chapter 6, please use THz instead of "Thz".

#### **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*