Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Timur Yagafarov

PhD Program: Physics

Title of Thesis: Polariton lasing in a dye-filled organic microcavities

Supervisor: Prof. Pavlos Lagoudakis

Date of Thesis Defense: 8 November 2019

Name of the Reviewer: Prof. Arkady Shipulin

I confirm the absence of any conflict of interest	**Signature:** **Date: 07-10-2019**

Reviewer's Report

The PhD thesis contains 5 Chapters. The first chapter is an introduction, where state of the art in this area is described in details as well as the main goals of PhD thesis, namely: (i) proof of the possibility of control over a polariton lasing emission wavelength and (ii) explanation of the blueshift mechanism. The latter is the limiting factor of tunability precision. The PhD thesis topic is of great interest for future applications in such field as wavelength tunable organic polariton lasers utilizing strongly-coupled microcavities. Light-matter coupling mechanisms, consideration of the cavity photons and excitons, exciton-polaritons states, as well as polariton lasing process and corresponding mechanisms in the organic microcavities are described in Chapter 2. Chapter 3 is dedicated to the realization of the broadly wavelength tunable (of 37 nm) at room-temperature polariton laser. Organic microcavity design and developed experimental setup are also explained. Chapter 4 addresses the blue shifts in organic polariton condensates. The comprehensive experimental and theoretical studies of the blue shift origins in the organic polariton condensates were performed and a simple model was suggested. Chapter 5 contains the conclusions as well as further outlooks for improvements. The bibliography list consists of 67 references.

This PhD thesis is an example of a unique combination of a high quality experimental work and adequate qualitative theoretical explanations. Both experimental and theoretical studies were complimentarily used for characterization of prepared organic structures and construction of complex setup for dispersion analyses of the prepared microcavities.

One part of the main results of PhD thesis has been published in high impact international journal Advanced Optical Material (IF=7.125) and Nanotechnology (IF=3.399). Another part has been placed in ArXiv (arxiv.org/abs/1905.02573) and currently is under revision in new journal of Nature publishing group - Communications Physics. The main scope of this journal is significant advances bringing unique insights into a specialized area of research in physics.

The quality of the publications is very high and is confirmed by IF of journals. The contribution of the presented PhD thesis author in the published and submitted articles is described in detail. The level of journals, where PhD thesis results were published, demonstrates the scientific significance of the obtained results. Affiliation of co-authors as well as level of journals and references show high (according to the international standards) level of the PhD thesis results.

One of the perspective directions of application of the obtained results is the microdisplays or scanning lasers for augmented reality with direct retinal projection.

It is necessary to consider before the thesis defense the following comments and remarks:

1) Page 78. Molar absorption coefficient and molecular weight were given without units. The SI unit of the molar absorption coefficient is m^2mol^{-1}. Also called extinction coefficient, but usually in units of $dm^3cm^{-1}mol^{-1}$. Molecular weight is measured in unified atomic mass units (u or Da);
2) Bibliography list consists of only 67 references. It is an unusual number of references for the PhD thesis. The typical number for a PhD thesis is more than one hundred references.

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*

Shipulin Arkady 13.10.2019