

## Jury Member Report – Doctor of Philosophy thesis.


**Name of Candidate:** Aleksandra Boldyreva

**PhD Program:** Materials Science and Engineering

**Title of Thesis:** Unraveling bulk and interfacial degradation mechanisms in perovskite solar cells

**Supervisor:** Prof. Pavel Troshin

**Name of the Reviewer:** Eugene A. Goodilin, Moscow University

I confirm the absence of any conflict of interest	<b>Signature:</b>  <b>Date: 05-06-2020</b>
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*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

The reviewed PhD thesis of Aleksandra Boldyreva discusses a highly important problem of photochemical and irradiative degradation of hybrid perovskites in a new advanced generation of solar cells, perovskite solar cells, PSCs. This is, without doubts, one of the most vital, key issue for current and future emergent development of perovskite photovoltaics. This topic limits practical implementation of new solar devices and thus has to be solved and elaborated deeply prior the future applications of PSCs. The work is surely a world class original research with new important experimental findings in the fields of materials science, physical, organic and inorganic chemistry. The latter seems to be a highly useful and constructive feature of the thesis. The author tries to find both a reason and consequences of various degradation pathways in a sandwich structure of PSCs describing highly realistic models of possible processes including assumptions on interfacial chemistry peculiarities in this highly complicated system. The author applied a self – sufficient set of modern experimental and analytical approaches to confirm all the details of experimental results and, therefore, the proposed interpretation of the data, intermediate and final conclusions are very trustful. The whole work makes a good contribution to the field, its scientific and practical significances are high at the international level and it fits well recent world – wide trends of research in perovskite photovoltaics.

The dissertation is of high quality, well written and structured, richly illustrated by 71 figures, 6 tables, 2 schemes, contains abstract / introductory, needed technical and 5 thematic chapters, the conclusion and bibliography sections. The topic of dissertation is relevant to its actual content. The personal contribution of the author to the overall work, revealed new data and their evaluation, experimental procedures etc. seems to be predominant. Also, the majority of the obtained results are well disseminated in high rank author's publications in key high impact interdisciplinary and specialized international journals (mostly Q1).

My final remarks is that *I recommend the candidate to defend the thesis by means of a formal thesis defense*, everything is ready for that and the result, I think, will be highly positive. The work is strong, deep and interesting.

I have no critical issues to be addressed before the thesis defense, however I would be, hypothetically, delight if a thorough TEM / HREM investigation could be undertaken for studying of local defect generation upon different stages of degradation while I understand that those hybrid perovskites is a gentle matter exposing a risk of damage in vacuum under an electron beam. Probably, it is out of scope of the current work and could be considered as its possible continuation. A general question remains in the contest of complex interrelation between thermal, thermodynamic and phorochemical stability if we could find reliable correlations between the perovskite composition and operational stability of the PSCs, or the most of reported effects are just related to reaction ability of substances and kintetics of their interaction with accents made due to a small thickness of the layers in the PSC architecture.

#### **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*