

## Jury Member Report – Doctor of Philosophy thesis.

**Name of Candidate:** Patrick Aggrey

**PhD Program:** Materials Science and Engineering

**Title of Thesis:** Nanoscale phase separation and transformations in the silicon-oxygen and related systems

**Supervisor:** Professor Alexander Korsunsky

**Co-supervisor:** Alexey Salimon, Senior Research Engineer

**Name of the Reviewer:** Henni Ouerdane, Associate Professor

I confirm the absence of any conflict of interest

(Alternatively, Reviewer can formulate a possible conflict)

**Date: 25-05-2023**

*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

Reviewers report should contain the following items:

- **Brief evaluation of the thesis quality and overall structure of the dissertation**

The doctoral thesis manuscript is composed of 4 chapters, including the Introduction and Conclusion. The Introduction is quite long as it contains a literature review. Chapter 2 offers an in-depth description of the materials and methodology to conduct the research. Chapter 3 provides a wealth of results, which are systematically discussed. The Conclusion summarizes the work and presents the main outcomes of the research. Overall, the dissertation is simply yet adequately structured.

- **The relevance of the topic of dissertation work to its actual content**

Silicon-based materials are widespread in science and technology and serve as the basic materials for many commercialized applications. While the bulk forms have long been used in the glass and ceramics industries, nanostructured forms present an interest for the development of new solar cells and progress

in electrochemical energy storage with silicon-based Li-ion battery anodes. However, to foster these developments, control and optimization of the production of silicon-based nanostructures to harness their properties, e.g. optical, thermal, chemical, is a must. The research work presented in the dissertation focuses on the synthesis and properties of silicon-based powders and porous consolidates considering the effects of thermally induced phase transformations in the silicon-oxygen system. The relevance of the topic and of the thesis content is clearly established.

- **The relevance of the methods used in the dissertation**

Chapter 2, Materials and Methodology, the scientific and technical approaches to work on the diatom-derived silica are described in sufficient details. Synthesis processes and characterization techniques that correspond to current international standards have been applied. Interestingly, it appears that this part of the work on the synthesis and characterization was truly beneficial to the candidate not only in terms of practice and know-how, but also for the better understanding of the properties of the materials studied in this research.

- **The scientific significance of the results obtained and their compliance with the international level and current state of the art**

Publications and citations are a convenient way to see that the scientific results are novel, significant, and on par with current international state of the art. Chapter 3 offers nearly 50 pages of results and discussion on heat treatment, powder characterization, phase separation, optical properties and other. The produced scientific results are not only of interest for the community that specialize in materials synthesis, but can bring benefit in research on novel solar cells and silicon-based Li-ion battery anodes, which are currently quite topical for electrical power production and storage.

- **The relevance of the obtained results to applications (if applicable)**

While the doctoral work presented in the thesis manuscript correspond to the level 1 of the technology readiness level scale, the results obtained can certainly be used by teams working prototypes corresponding to level 4, where the technology (solar cells or anodes for instance) are tested in laboratory environments.

- **The quality of publications**

The candidate has published several papers, including original articles and conference proceedings, in reputable Scopus and WoS indexed journals. He is first author of 5 of them. The Scopus database in particular indicates 30 citations so far and h=4, which is very good for a PhD candidate. These numbers show that the research community has an interest in the candidate's research works and results, which is a recognition of the quality of the publications.

### **Summary of issues to be addressed before/during the thesis defense**

My criticism is rather light: Chapter 3, Results and Discussion, is quite bulky and could easily be split into two different chapters given the number of results, which deal with various aspects and properties of the materials; but this depends on how the candidate wants to construct his narrative. Chapter 2 is on the

contrary quite short considering the all techniques and materials discussed. It appears as an imbalance in the writing of the thesis.

Note that a similar comment might be made for the Introduction Chapter, which could be split into two parts: one that ends at section 1.2 Overall Aims of the Thesis, and the rest which can constitute a literature review chapter. But again, it is a matter of editorial choice made by the author.

The Conclusion chapter provides a good recap of the work and ending with the list of outcomes as the take-home message is fine. However, this does not quite mirror the “general questions” listed in the Introduction, section 1.2. A clearer or more direct link between the outcomes and the questions would be good.

**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*