Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Nikita Akhmetov

PhD Program: Materials Science and Engineering

Title of Thesis: Development of lithium-conducting polymer-ceramic membranes for lithium-metal hybrid flow batteries

Supervisor: Professor Keith Stevenson

Name of the Reviewer:

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Signature:** **Date: 01.10.2023**

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

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 presented Doctoral Thesis "Development of lithium-conducting polymer-ceramic membranes for lithium-metal hybrid flow batteries" by Nikita Akhmetov is devoted to a very hot and important topic – redox flow batteries. In spite of tremendous recent success has achieved in the field of flow batteries, there is the lack of a suitable solid electrolyte: a membrane with high ionic conductivity (IC) and selectivity, flexibility and integrity, stability in Li-HFB environment. The thesis follows the ceramic-in-polymer approach in membrane design and develop a composite consisted of Li1.3Al0.3Ti1.7(PO4)3 (LATP) filler and poly(vinylidene fluoride) (PVdF) matrix.

The thesis consists of five chapters set forth on 204 pages. The thesis describes main results published in the papers, logically structured, however could be slightly improved. My comments related to the thesis structure:

- The list of figures and tables (p.16-22) is not necessary, and can be easily cut off without harming the quality of the thesis. This is old style, atavism.
- The thesis should start with short (2 page) Introduction showing the importance, revealing the challenges, and setting the goals for the thesis.
- Chapter 5. Final Remarks is outside of the accepted structure of the thesis or should be properly named. Usually the last section contains Conclusions and Future Perspectives (work).
- Formulas and equations are part of the sentences and should follow the punctuation rules: commas and full periods are missing.

Specific comment: p.14: ASSB — solid-state battery.

The dissertation is based on five co-authored publications, in two of which Nikita contributed as the first author. The papers are published in high quality journals with high impact factors: J. Mat. Chem. A. (impact factor of 11.9), Membranes (4.56), J. Mem. Sci. (10.53), J. Energy Storage (8.91), ACS Appl. Mater. Interfaces (10.38). The number and level of publications as well as the position of the PhD candidate in the co-author's list apparently show his strong contribution to the research field.

In general, the contribution of Nikita Akhmetov to the field of redox flow batteries is important and substantial. The dissertation is written in a very good scientific language, very accurately with practically no orthographic misprints and errors. Nikita carried out most of the work, contributed to fundamental studies of the dissertation, and cowrote the papers, which are the basis for his dissertation. He has sufficient number of scientific publications on the same as dissertation topic. Nikita Akhmetov's dissertation is an original work possessing fundamental novelty and practical importance. I strongly recommend the author of this thesis for the PhD degree. The manuscript can be accepted for publication as a doctoral dissertation after minor changes.

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*