Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

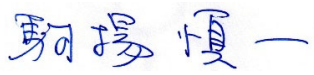
Name of Candidate: Maksim Zakharkin

PhD Program: Materials Science and Engineering

Title of Thesis: NASICON-type $Na_{3+x}Mn_xV_{2-x}(PO_4)_3$ cathode materials for sodium-ion 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:** Shinichi Komaba  **Date: 20-12-2020**

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 doctoral thesis by Maksim Zakharkin deals with electrochemistry of sodium insertion materials of sodium manganese vanadium phosphate having NASICON structure and their applicability to positive electrode of sodium-ion batteries. The overall scientific quality of thesis is so high considering previous studies in this research field, and the structure and study of the dissertation are well arranged and considered in the both scientific and engineering points of view. Rechargeable batteries like lithium-ion and lead acid batteries play critical role in IT technology and energy sustainability. Compared to these conventional batteries, sodium-ion batteries recently attract much attention because sodium-ion batteries can be designed without costly and toxic metal elements like Co, Li, Pb, Cu and so on.

In this thesis, new phosphate materials are successfully developed and studied with strong and advanced characterization tools including operando technique in battery cell. The reviewer recognizes scientific significance of the results obtained considering the international level and current state of the art. The finding in the thesis is believed to contribute to new science of designing new electrode materials as well as development of high-performance rechargeable batteries free from minor and toxic metals. The results presented in the thesis were already published in highly impacting journals and the quality of publication is considered to be high. Therefore, the referee surely recommend that the candidate should defend the thesis by means of a formal thesis defense.

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*