

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Roman Kapaev

PhD Program: Materials Science and Engineering

Title of Thesis: Transition metal coordination polymers derived from 1,2,4,5-benzenetetraamine as active materials for energy storage devices

Supervisor: Professor Keith Stevenson

Name of the Reviewer: Chao Luo

I confirm the absence of any conflict of interest.

Date: 27-10-2021

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 Ph.D. candidate, Roman Kapaev, wrote a high-quality thesis for transition metal coordination polymers as redox-active materials in alkali-ion batteries. The thesis introduced the background information such as the working principles of rechargeable batteries, basic concepts and applications of metal organic energy storage materials. It provides a guidance for the design, synthesis, and application of polymeric electrode materials in alkali-ion batteries. The research results and discussion are also provided with in-depth discussion and conclusion. The overall structure of the dissertation is clear and logical. The content in the dissertation is highly related with the topic, and methods are clearly described.

The work in this dissertation focuses on the design and synthesis of metal-organic polymers as anode materials for alkali-ion batteries, including Li-ion/Na-ion/K-ion batteries. The resulting polymeric materials are well characterized and exhibit excellent electrochemical performance in terms of high reversible capacity and long cycle life. The reaction mechanisms of the newly devised polymers in alkali-ion batteries are also proposed and confirmed by testing the structural evolution of cycled materials with XRD, XPS, UV-Vis-NIR, and Raman spectroscopy. The results are critical for the development of high-performance and sustainable next-generation energy storage devices. The importance and novelty of the work in this dissertation are very high.

Na-ion/K-ion batteries are promising alternatives to commercial Li-ion batteries due to the low cost, high abundance, and similar electrochemistry of Na ion/K ion versus Li ion. The polymeric anode materials developed in this dissertation show superior electrochemical performance in these emerging battery systems, and thus they have great potentials for the applications in next-generation sustainable energy storage devices. Moreover, the candidate published two high-quality research articles in peer-reviewed international journals and one high-impact review article in peer-reviewed international journal. I think the candidate is well-qualified for a Ph.D. based on his achievements.

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