

## OPINION

on a dissertation for the acquisition of the educational and scientific degree of PhD in Professional Field 4.2 Chemical Sciences, Doctoral Program “Solid State Chemistry”

**Candidate:** Evelina Yordanova Vassileva

**Topic of the dissertation:** “Porous metals obtained by selective dissolution of alloys – suitable electrode materials in ion batteries”

**Reviewer:** Ivan Aleksandrov Kanazirski, PhD, Associate Professor at University of Mining and Geology St. Ivan Rilski

The dissertation contains 116 pages, 54 figures and 4 tables. 230 literature sources are cited.

In terms of volume, structure and layout it fully meets the requirements for a dissertation for a doctoral degree.

In her dissertation, the PhD candidate sets herself the main objective of obtaining two-component (Zn-Sn) and three-component (Zn-Sn-Bi и Cu-Ag-Al) alloys under different crystallization conditions from a melt.

The objective is pursued through achieving a suitable selective electrochemical dissolution of the less noble metal from the alloys, and obtaining porous structures. The ultimate goal is the application of those structures for electrochemical energy storage.

The topic of the dissertation is particularly relevant, in view of the “green transition” and the search for ways to sustainably store energy derived from renewable sources.

It is important to emphasize the very clear formulation and measurability of the objectives. To achieve them, a series of tasks have been defined, namely:

- obtaining a series of alloys applying two different approaches;
- optimizing the experimental conditions of the electrochemical dissolution;
- investigating the changes in the morphology and microstructure of the materials;

– studying the potential application of the obtained porous materials as electrodes in lithium-ion and sodium-ion batteries.

The research has been planned so as to achieve a more thorough thermodynamic, electrochemical and structural characterization of the materials obtained. A variety of methods for analysis and characterization have been aptly selected, such as:

- X-ray diffraction analysis;
- transmission electron microscopy (TEM);
- energy-dispersive spectroscopy;
- potentiodynamic polarization analysis;
- analysis of potentiostatic curves;
- scanning electron microscopy;
- BET analysis of surface area and porosity.

From the contributions set out by the candidate, it is evident that the main objectives of the dissertation have been achieved. I specifically draw attention to the third conclusion, that “The porous structures based on Bi and Sn are shown to be suitable negative electrodes in Li/Na ion batteries, operating on the “alloying” principle with Li/Na. The measured discharge capacities are promising and motivate the expansion of research in the direction of optimizing the microstructure of the alloys, in order to achieve high and stable cycling capacity of the battery”.

Clearly, there is a promising direction for further research.

As a minor remark, I would recommend that the conclusions be generalized to cover all types of alloys studied. This, in my opinion, would emphasize the comprehensiveness of the study.

An important indicator of the value of the results obtained in the dissertation are the candidate’s publications in international journals with an impact factor: *Journal of Alloys and Compounds*, IF 6.371 (Q1), *Dalton Transactions*, IF 4.569

(Q1), *Journal of Porous Materials*, IF 2.523 (Q2). Parts of the results have been presented at two national scientific forums.

I do not know the PhD candidate in person. My impressions are only from the preliminary presentation of the dissertation, where Evelina Vassileva did an excellent job, demonstrating a very good knowledge of research techniques and a logical interpretation of the results.

Based on the above, I believe that the submitted dissertation has all the required qualities, and the candidate fully deserves to be awarded the educational and scientific degree of PhD.

01.09.2023

Assoc. Prof. Ivan Kanazirski, PhD