

REVIEW

for the PhD abstract for the Doctor of Philosophy (PhD)
in Chemical Sciences Xu Xieyu:

«Li-conductive ceramic electrolyte with NASICON structure for solid-state
batteries»,

1.4.15. Solid State Chemistry

Obtaining new functional materials is impossible without a detailed understanding of the composition - structure - properties relationships. Scientific research on the development of new materials for secondary power supplies is relevant and practically significant. Reducing the costs of LIBs, associated with the development of new electrode materials, as well as the use of new generations of materials based on solid-state electrolytes, which make it possible to achieve significant gain and improvement in terms of specific energy, power and safety of devices today. As part of Xu Xieyu's dissertation work, samples of the Li-conducting ceramic electrolyte $\text{Li}_{1+x}\text{Al}_x\text{Ti}_{2-x}(\text{PO}_4)_3$ with the NASICON structure were synthesized, and their structure and properties were studied. Therefore, Xu Xieyu's work certainly seems relevant.

The author has done the synthesis of $\text{Li}_{1+x}\text{Al}_x\text{Ti}_{2-x}(\text{PO}_4)_3$ solid-state electrolyte powdered precursors by the solid-state method, the molten salt quenching method and synthesis using polymerized matrices. An analysis of the influence of the background of obtaining ceramic precursors, the peculiarities of their formation, temperature and time processing conditions on the sintering processes and the microstructure of solid-state electrolyte samples was carried out. Effective methods have been developed for producing high-density ceramic materials of the composition $\text{Li}_{1.3}\text{Al}_{0.3}\text{Ti}_{1.7}(\text{PO}_4)_3$ with the NASICON structure.

The scientific novelty and relevance of the results obtained is beyond doubt, and their reliability and correctness are determined by the modern complex of equipment and software used. The presented scientific provisions submitted for defense are justified. Based on the dissertation results, 5 scientific works of the author have been published. The results of the work were presented at 4 international and Russian conferences.

Xu Xieyu's PhD abstract is written in clear scientific language, is characterized by consistency, completeness and clarity of presentation and represents a completed, focused study.

1. The author provides the values of the relative density of the obtained ceramic electrolytes, but does not discuss what method or methods were used to measure the relative density of the ceramic samples?
2. When modeling the destruction process of a polycrystalline cell, does the result depend on the pore geometry? Why did you choose *octagonal* geometry?
3. As follows from the description of the experiments, for electrochemical measurements a layer of platinum 30 nm thick was deposited on the fuel cell. How does the introduction of an additional technological stage affect scaling processes?

4. How was the cathode mass prepared for a full cell? Did you add LATP to it or soak it in liquid electrolyte?
5. The reaction of LATP with lithium metal may explain the voltage fluctuations during cycling of symmetrical cells (Fig. 18, 19) and may not be related to the mechanical properties of solid electrolytes. A similar question is associated with the reasons for the degradation of the full cell in Fig. 19 b,c - is it caused by the reaction of the anode with the solid electrolyte or degradation of the cathode material?

The work «Li-conductive ceramic electrolyte with NASICON structure for solid-state batteries» meets the requirements established by the M.V. Lomonosov Moscow State University for this kind of works. The content of the work corresponds to specialty 1.4.15 - "Solid State Chemistry", namely the following directions: 1) development and creation of methods for the synthesis of solid-phase compounds and materials; 2) establishment of "composition-structure-property" correlation for solid-phase compounds and materials; 3) study of the influence of synthesis conditions, chemical and phase composition, as well as temperature, pressure, irradiation and other external influences on the chemical and chemical-physical micro- and macroscopic properties of solid-phase compounds and materials, as well as the criteria defined in paragraphs 2.1-2.5 of the Regulations on the awarding of academic degrees at the M.V. Lomonosov Moscow State University, and also drawn up in accordance with the requirements of the Regulations on the Council for the Defense of Dissertations for the Doctor of Philosophy in Chemical Sciences, Lomonosov Moscow State University.

Thus, applicant Xu Xieyu deserves to be awarded the academic degree of the Doctor of Philosophy (PhD) in Chemical Sciences in specialty 1.4.15 - Solid State Chemistry.

Dr. Stanislav S. Fedotov
Assistant Professor, PhD in Chemistry
Center for Energy Science and Technology
Skolkovo Institute of Science and Technology
E-mail: s.fedotov@skoltech.ru



13.05.2024

*Hereby I confirm the signature of Dr. Stanislav S. Fedotov
Skoltech Head of HR administration*

