



HAL
open science

Iron and sulfate based positive electrode materials for Na-ion batteries

Anastasia Grebenschikova, Jacob Olchowka, Loïc Simonin, Laurence Croguennec, Christian Masquelier

► **To cite this version:**

Anastasia Grebenschikova, Jacob Olchowka, Loïc Simonin, Laurence Croguennec, Christian Masquelier. Iron and sulfate based positive electrode materials for Na-ion batteries. 24th International Conference on Solid State Ionics, International Society for Solid State Ionics, Jul 2024, Londres, United Kingdom. <hal-04757305>

HAL Id: hal-04757305

<https://hal.science/hal-04757305v1>

Submitted on 28 Oct 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY-NC-ND 4.0 - Attribution - Non-commercial use - No Derivative Works - International License

Iron and Sulfate Based Positive Electrode Materials for Na-ion Batteries

GREBENSHCHIKOVA, Anastasia^{*a,b,c}, OLCHOWKA, Jacob^a, SIMONIN, Loïc^b, CROGUENNEC, Laurence^a, MASQUELIER, Christian^c

Affiliations:

^aInstitut de Chimie de la Matière Condensée de Bordeaux, Bordeaux INP, ICMCB UMR 5026, F-33600 Pessac, France, ^bLaboratoire de Réactivité et Chimie des Solides, Université de Picardie Jules Verne, CNRS-UMR7314, F-80039 Cedex 1 Amiens, France, ^cLaboratoire d'Innovation pour les Technologies des Energies Nouvelles et les nanomatériaux CEA, LITEN, F38054 Grenoble, France

Concept of Na-ion batteries is among the most promising battery technologies to deal with the issue of critical and scarce elements used in Li-ion batteries. Portable applications demand high energy density, favoring V- and Mn-based Na-ion positive electrode materials. In contrast, for stationary applications where battery weight is less critical, component cost becomes a more compelling factor. Stable polyanionic frameworks ensure longer cycling life as well as greater safety in comparison to layered oxides. In 2023 Mn has been classified as a critical raw material by EU committee, which promotes search and development of new materials based on abundant Fe. For the polyanionic part, phosphates are widely studied, leaving space for investigation of pure sulphate phases and in parallel for mixed phosphate-sulphates.

From this point of view, we revisited already reported $\text{NaFe}_2\text{PO}_4(\text{SO}_4)_2$ (NFPS), which crystallizes in NaSICON structural type [1-4]. High-purity samples of NFPS were synthesized and studied by means of X-ray, neutron and electron diffractions, scanning electron microscopy and electrochemical methods. A new description of the structure was proposed and the relationship between synthesis conditions, stoichiometry, structure, and electrochemical performance will be discussed. Optimization of morphology and electrode formulation allowed us to obtain theoretical capacity at C/30 cycling rate (mass loading 20 mg/cm²). Step-by-step up-scaling led to synthesis of 8 g of NFPS per batch.

Attempts to synthesize sodiated compound of the same element compositions as NFPS via easy up-scalable solid-state synthesis result in new alluaudite-type series of phases. Challenges of the synthesis linked to control of stoichiometry and promising electrochemical performance will be presented.

A new phase based on only abundant elements, such as Na, Fe and S, obtained via simple ball-milling procedure, could be suggested as a cheap and efficient positive electrode material for stationary storage. Its synthesis requires only two easily-available precursors and no heating is required. One of the main advantages of this material is excellent stability of cycling. Structure and electrochemical experiments would also be presented.