ELMINA 2022

SECOND INTERNATIONAL CONFERENCE ON ELECTRON MICROSCOPY OF NANOSTRUCTURES

ДРУГА МЕЂУНАРОДНА КОНФЕРЕНЦИЈА О ЕЛЕКТРОНСКОЈ МИКРОСКОПИЈИ НАНОСТРУКТУРА

August 22nd–26th, 2022, Belgrade, Serbia
22–26. август 2022. Београд, Србија

SECOND INTERNATIONAL CONFERENCE

ELMINA 2022

Serbian Academy of Sciences and Arts, Belgrade, Serbia
August 22nd-26th, 2022
http://elmina.tmf.bg.ac.rs

Program and Book of Abstracts

Organized by:
Serbian Academy of Sciences and Arts
and
Faculty of Technology and Metallurgy, University of Belgrade

Endorsed by:
European Microscopy Society
and
Federation of European Materials Societies

Title: SECOND INTERNATIONAL CONFERENCE
ELMINA 2022
Program and Book of Abstracts

Publisher: Serbian Academy of Sciences and Arts
Knez Mihailova 35, 11000 Belgrade, Serbia
Phone: +381 11 2027200
https://www.sanu.ac.rs/en/

Editors: Velimir R. Radmilović and Vuk V. Radmilović

Technical Editor: Vuk V. Radmilović

Cover page: Raša Hindawi

Printed in: Serbian Academy of Sciences and Arts
Knez Mihailova 35, 11000 Belgrade, Serbia
Phone: +381 11 2027128
stamparija@sanu.ac.rs
Circulation: 55 copies.

Sodium-pillared vanadium oxide decorated with carbon particles as electrode material for more sustainable energy storage of the future

Milica Vujković[1], Tamara Petrović[1], Dušan Mladenović[1], Miloš Milović[2], Danica Bajuk-Bogdanović[1], Biljana Šljukić-Paunković[1], Slavko Mentus[1,3]

1 University of Belgrade-Faculty of Physical Chemistry, Studentski trg 12-14, Belgrade and Serbia.

2 Institute of Technical Sciences of Serbian Academy of Sciences and Arts, Knez Mihajlova 35/IV, 11000 Belgrade, Serbia.

3 Serbian Academy of Sciences and Arts, Knez Mihajlova 35, Belgrade, Serbia.

An increased utilization of intermittent renewable energy (wind, solar…) requires the expansion of energy storage/conversion systems to a large scale, which can be integrated with renewable source devices into electrical grid. The state-of-the-art Li-ion batteries present the good choice in terms of energy and power density. However, their massive applications are strongly limited by restricted lithium resources and safety issues. In that context, the research on different alternative battery systems, relying on Earth abundant elements such as Na, Ca, Mg, Al, etc, have been launched, where advanced materials play the central role as electrodes in their operation [1,2].

Due to adaptable interlayer distance and multivalent stage of vanadium, layered vanadium oxides are interesting electrode materials for multivalent-ion charge storage devices. Herein, the multiphase Na-pillared vanadium oxide was hydrothermally synthesized in the form of the composite with carbon (SVM/C) to serve as a platform for understanding mono/multivalent ion chemistry and to be examined as an electrode for different aqueous rechargeable batteries. The carbon (Vulcan XC72) presence in the precursor solution during the synthesis of targeted $Na_2V_6O_{16}$, was found to change the reaction path, leading to a phase mixture $Na_2V_6O_{16}/NaV_6O_{15}$ (SVM/C) instead of the expected single $Na_2V_6O_{16}$ phase. Both Scanning electron microscopy (SEM) and Transmission Electron microscopy (TEM) revealed nanowire nanosphere arrays of SVM/C (Fig1). Some of nanowires are stacked into larger parallel bundles, 2-3 μm in diameter (Fig.1, left), while the spherical-shape particles (≈ 100 nm in diameter) are grouped into smaller or larger clusters, with the tendency to form chains (Fig.1, right). The amount of carbon in the composite, determined by thermogravimetric and differential thermal analysis (TG/DTA), was found to be ≈ 8 wt.%.

The applicability of the synthesized composite as electrode material was first checked in Li-ion aqueous battery. As anode of SVM/C//$LiNO_3$//$LiFe_{0.95}V_{0.05}PO_4$/C full cell, multiphase SVM/C composite shows better performance than those for reported NaV_6O_{15} and $Na_2V_6O_{16}$ anodes in the form of either Li or Na rechargeable aqueous batteries. Furthermore, the high insertion capability of the synthesized multiphase oxide was shown not only in Li but also in Mg-, Al- and Ca-containing aqueous electrolytes. The main novelty we found here is that Ca redox processes of sodium vanadate in an aqueous solution are more stable than Li and Mg redox processes. Significantly higher Ca^{2+} vs. Li^+ capacity retention (87 vs. 45 wt%) is shown during prolonged potentiodynamic cycling and that was explained by coinserted water/hydroxyl groups. Hydroxyl groups introduced by coinsertion, as evidenced by Fourier-transform infrared spectroscopy (FTIR), may take over the charge fraction and make vanadium ions less strained, thus producing better cyclic stability. Their redox process during charging/discharging of vanadium oxide is proposed. The influence of different parameters (pH, the type of anion and electrolyte concentration) to the stability of Ca redox processes is examined. The synthesized SVM/C is combined with the carbon anode to get the aqueous multivalent hybrid cell, whose performance will be presented.

With these results, we would like to put in motion the interest for Ca interfacial reactions of vanadate structures, in the aqueous-based electrolytes, as new directions towards development of a new generation of more sustainable energy storage devices.

References:

[1] C. Masquelier, L. Croguennec, Chemical Reviews, 113, (2013), p. 6552.
[2] A. Gezović, M. J. Vujković, M. Milović, V. Grudić, R. Dominko, S. Mentus, Energy Storage Materials, 37 (2021), p. 243.
[3] This research is supported by the Science Fund of the Republic of Serbia, PROMIS, #6062667, HISUPERBAT.

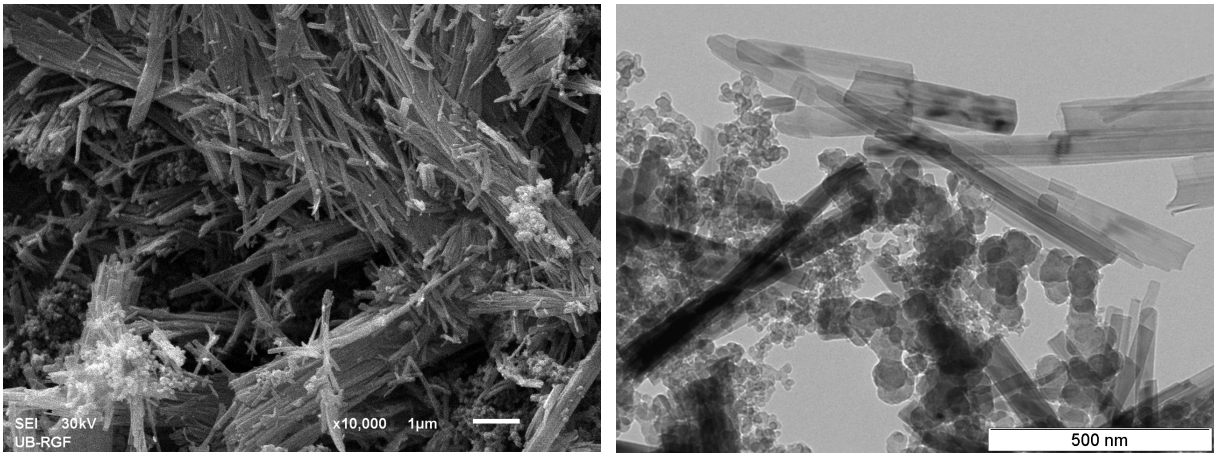

Figure 1. SEM (left) and TEM (right) micrographs of SVM/C.

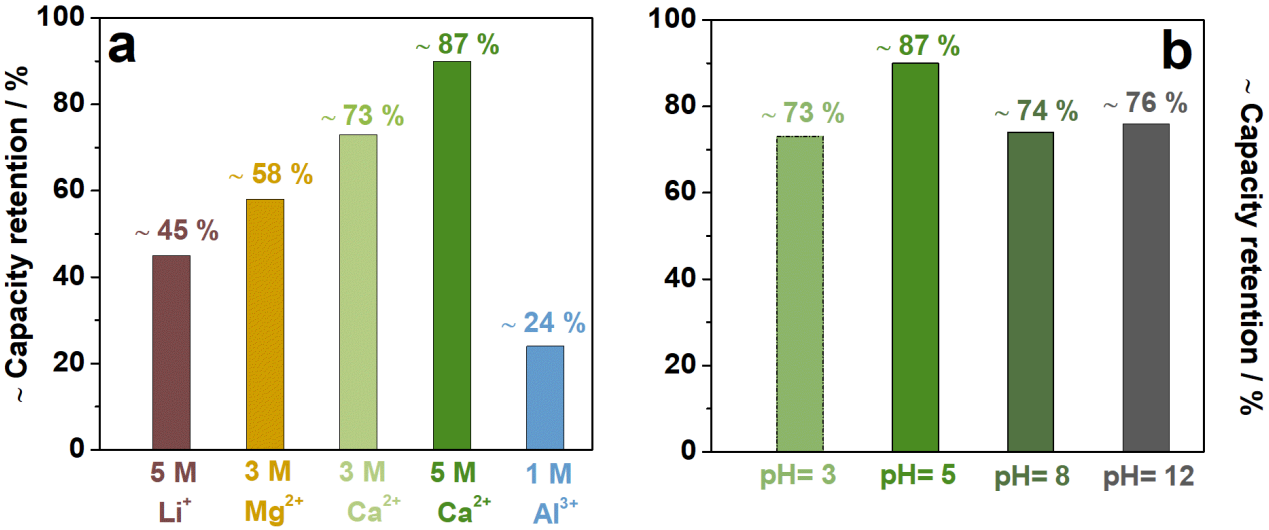

Figure 2. The capacity retention of SVM/C after 20 cycles in a) different M-containing aqueous electrolytes (M=Li, Mg, Ca and Al) and b) pH-different Ca-containing electrolytes.

CIP – Каталогизација у публикацији
Народна библиотека Србије, Београд

66.017/.018(048)
544.2(048)
621.385.833.2(048)

INTERNATIONAL Conference on Electron Microscopy of Nanostructures ELMINA (2 ; 2022 ; Beograd)
Program ; & Book of Abstracts / Second International Conference ELMINA [Electron Microscopy of Nanostructures] 2022, Belgrade, Serbia, August 22nd-26th, 2022 ; organized by Serbian Academy of Sciences and Arts and University of Belgrade, Faculty of Technology and Metallurgy ; [editors Velimir R. Radmilović and Vuk V. Radmilović]. - Belgrade : SASA, 2022 (Belgrade : SASA). - 223 str. : ilustr. ; 30 cm

Na nasl. str.: European Microscopy Society and Federation of European Materials Societies. - Tiraž 55. - Bibliografija uz svaki apstrakt. - Registar.

ISBN 978-86-7025-943-0

а) Наука о материјалима -- Апстракти б) Нанотехнологија -- Апстракти в) Електронска микроскопија -- Апстракти

COBISS.SR-ID 72022025