



The γ' -V₂O₅ Polymorph as an Attractive 2D Cathodic Material for Lithium and Sodium-Ion Batteries

R. Baddour-Hadjean, J.P. Pereira-Ramos

Institut de Chimie et des Matériaux Paris Est, ICMPE/GESMAT, UMR 7182 CNRS-Université Paris Est Créteil, CNRS 2 rue Henri Dunant, 94320 Thiais, France

E-mail: pereira@icmpe.cnrs.fr

Lithium-ion batteries (LIBs) have been the subject of intense research due to their high energy density and good cycling performance. However, considering the low natural occurrence of Li in the upper continental crust (≈ 35 ppm), great concerns have been expressed over whether the available lithium reserves in the earth will be sufficient to meet the ever-growing requirements for LIBs. Therefore, there is a call for batteries based on more earth-abundant alkali metals such as Na-ion batteries (NIBs) which have the second-lightest mass-to-charge ratio in the ranks of alkali metals after lithium. Layered materials with the van der Waals interlayer spacing constitute ideal frameworks for intercalation reactions of guest cationic species from which high discharge-charge rate and minimum structural distortions can be expected. Among them, vanadium pentoxide provides appealing prospects for use as advanced cathodes for secondary batteries. While orthorhombic α -V₂O₅ was identified very early as a promising cathode material for secondary Li batteries, studies concerning the use of V₂O₅ for sodium-based energy storage systems are limited. An alternative way to identify new attractive stable V₂O₅ polymorph consists in considering the chemical removal of metallic species from vanadium pentoxide bronzes MxV₂O₅.

In the present work, we report the electrochemical and structural behavior of a new lithium and sodium insertion compound, γ' -V₂O₅, prepared by the chemical oxidation of γ -LiV₂O₅ at RT. One lithium or sodium ion per mole of γ' -V₂O₅ can be inserted in γ' -V₂O₅ involving a high V⁵⁺/V⁴⁺ redox potential of 3.6 – 3.5V vs Li⁺/Li and 3.3 V vs. Na⁺/Na respectively. With a maximum specific capacity of 145 mAh g⁻¹ in both cases, the electrochemical insertion is a fully reversible process for Li ions while it is kinetically limited in the case of sodium insertion. The same voltage for both reactions reveals attractive properties of the γ' -V₂O₅ system. We will give here an overview of the main electrochemical features (specific capacity, rate capability, kinetics, cycle life) of γ' -V₂O₅ towards Li and Na insertion. Furthermore, a detailed insight into the Li and Na insertion mechanism through XRD and Raman experiments during the discharge/charge processes is performed for understanding the electrochemistry-structure relationships.

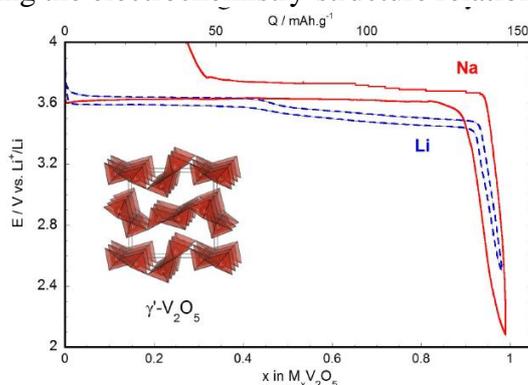


Fig. 3 Comparison of discharge-charge curves for γ' -V₂O₅ in a lithiated and sodiated electrolyte (C/10).

