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Spectroelectrochemical study of the lithium insertion in vanadium(V) oxide xerogels

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Abstract

Vanadium-oxide gels and xerogels are currently explored as versatile materials in lithium ion batteries. They consist of V_2O_5 nanoribbons composed by doubly-layered slabs joint by a strongly bond H_3O^+/H_2O intercalated layer. Their thin films exhibit a complex electrochemical behavior encompassing four reduction waves at 0.38, 0.22, -0.42 and -0.81 V vs $Ag/AgNO_3$ (0.503 *vs* SHE). In order to improve the understanding of such processes, a detailed spectroelectrochemical investigation was carried out based on visible-UV and confocal Raman spectroscopy. Accordingly, the first two waves were ascribed to the partial reduction of non-equivalent, localized V^V=O centers, keeping most of the representative vanadium-oxide vibrational features. At -0.4 V, a transition to a delocalized mixed-valence configuration became apparent in the optical and Raman spectra, leading to a dramatic current increase coupled with the insertion of lithium ions into the lamellar structure. At –0.8 V a complete conversion into the vanadium(IV) oxide form was observed from the spectroelectrochemical profiles. The nanoribbons doubly-layered structure seems to be preserved, sustaining a reversible and reproducible electrochemical behavior along several repetitive voltammetric cycles.

Keywords: V_2O_5 electrochemistry; V_2O_5 xerogel; V_2O_5 nanoribbons; V_2O_5 spectroelectrochemistry; Lithium insertion

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