XXI Brazilian Meeting on Inorganic Chemistry
X Brazilian Meeting on Rare Earths
III Workshop on Theoretical Bioinorganic Chemistry
Belo Horizonte, September 12 - 15th 2024

Synthesis of $LiMnPO_4$@Nb_2O_5/C composite for application as active material in aqueous Li-ion hybrid supercapacitors

Gabriel J. P. Tonon, Paulo F. R. Ortega and Garbas A. dos Santos Junior[1]

[1]Grupo de Estudos em Dispositivos de Armazenamento de Energia (GEDAE) Departamento de Química, Universidade Federal de Viçosa, Viçosa, Brazil
E-mail: gabriel.tonon@ufv.br

Thematic Area: Inorganic Electrochemistry

Keywords: hybrid supercapacitors, $LiMnPO_4$, niobium, composite.

$LiMnPO_4$ (LMP) is considered an important material for the new generation of energy storage systems, particularly due to its working potential of ~4.1 V (vs. Li/Li^+), which leads to high power density. However, LMP suffers from low electronic conductivity (approximately 10^{-10} S cm^{-1}) [1]. Various strategies can be employed to improve LMP's electrochemical performance, including doping, coating, and composite formation. In this context, niobium has garnered attention due to its broad range of applications. According to the Companhia Brasileira de Metalurgia e Mineração (CBMM), Brazil's Araxá niobium reserves account for three-quarters of the global supply of Nb [2]. Nb_2O_5 offers a good electrochemical performance and higher electronic conductivity than LMP (10^{-6} S cm^{-1}). In this work, we developed an in-situ composite of $LiMnPO_4$@Nb_2O_5/C, obtained by solvothermal synthesis of LMP in a Nb_2O_5 dispersion, followed by carbon coating via glucose carbonization. The resulting composite (~20% Nb_2O_5 by weight) was characterized by X-ray diffraction (Fig. 1a), revealing the presence of both orthorhombic $LiMnPO_4$ and monoclinic Nb_2O_5. Electrochemical performance was evaluated using galvanostatic charge/discharge tests (Fig. 1b) in a three-electrode cell with 1 mol L^{-1} Li_2SO_4 as the electrolyte. The composite (Nb20_180) exhibited superior electrochemical performance compared to LMP (LMPC_180), showing enhancements of 13.5% at 1.5 A g^{-1} (64.4 C g^{-1}), 14.6% at 1.0 A g^{-1}(79.64 C g^{-1}), 25.3% at 0.5 A g^{-1}(120.32 C g^{-1}), 8.6% at 0.25 A g^{-1}(174.78 C g^{-1}), and 6.4% at A g^{-1}(293.28 C g^{-1}). This improvement in electrochemical performance can be attributed to the composite better electronic conductivity, as evidenced by the dQ/dV curves (Fig. 1c), where the Mn^{3+}/Mn^{2+} process occurs with a lower potential difference.

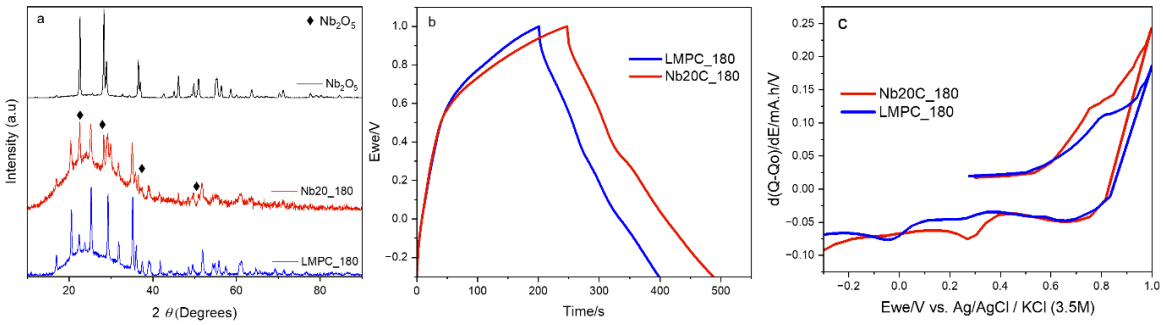

Figure 1 – (a) XRD of LMPC_180 and Nb20_180 compared to N2O5. (b) Galvanostatic charge/discharge curves (0.5 Ag^{-1}) and (c) dQ/dV curves (1.0 A g^{-1}) for LMPC_180 and Nb20_180

Acknowledgments: Fapemig APQ-02780-18 and APQ-00469-22.

References

[1] Yi. Hongming *et al*, Batteries-basel, **9**, (2023).
[2] G. Ricardo, M. Bruno, Atelie Geográfico, **14**, 142-162 (2020).