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

Evaluating surfactant use and temperature in hydrothermal synthesis of Prussian blue analogues for sodium ion supercapacitors application

Yago H. C. Fernandes, Iury D. Ferreira, 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: garbas.junior@ufv.br

Thematic Area: Inorganic Electrochemistry

Keywords: Prussian blue, Na-ion supercapacitor, energy storage

Na-Ion hybrid supercapacitors (SHSCs) are crucial for the new generation of electrochemical devices and for replacing Li devices due to their future scarcity. The high-power density of SHSCs and the abundance of Na make them exceptional. Among Na battery materials, Prussian Blue Analogues (PBAs) are notable for their ease synthesis, low cost, versatility, and capacity for reversible insertion/extraction of Na into their structure [1]. In this work, we synthesized $Na_xMn[Fe(CN)_6]$ (MnHCF) and investigated the effects of different temperatures and surfactant during synthesis for application as active electrode materials in SHSC. All materials were synthesized via hydrothermal method at 120°C and 150°C, both with and without polyvinylpyrrolidone (PVP), resulting Mn120; Mn150; Mn120P; Mn150P samples. XRD analysis confirmed a monoclinic structure for all materials (fig. 1A), while FTIR spectra revealed characteristic bands such as CN (2100 cm^{-1}), Fe-CN (600 cm^{-1}), H_2O (3700 cm^{-1}, 3650 cm^{-1} and 1600 cm^{-1}) for all samples (fig. 1B). Additionally, NH (3300 cm^{-1}) bands were observed in the spectra of Mn120P and Mn150P, due to remaining PVP. Both analyses confirm that in all cases the PBAs were synthesized. The materials were analyzed by galvanostatic charge discharge technique in a three-electrode electrochemical cell, using aqueous electrolyte of $NaClO_4$, 1 mol L^{-1}. When analyzing the effect of temperature on capacitance (C g^{-1}) at 0.25 A g^{-1}, we observed: Mn120 (50.1) < Mn150P (253.2) < Mn120P (313.6) < Mn150 (361.6), fig. 1C. This shows a positive effect of increased temperature for syntheses without PVP (Mn120 to Mn150) and a negative effect with PVP (Mn120P to Mn150P). PVP addition was beneficial at 120°C, increasing capacitance from Mn120 to Mn120P, but detrimental at higher temperatures (Mn150 to Mn150P). The performance boost from Mn120 to Mn150 is likely due to higher crystallinity and structural stability. PVP's positive effect at lower temperatures is due to its particle growth limitation and PBA nanoparticle stabilization, while the negative effect from Mn120P to Mn150P is likely due to reduced PVP protection, leading to less favorable morphologies for electrochemical applications.

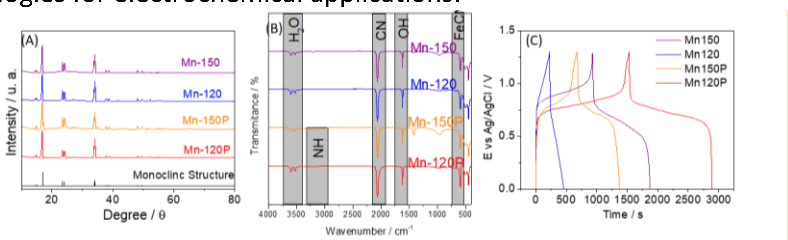

Fig. 1 (A) XRD (B) FTIR (C) galvanostatic charge discharge at 0.25 A/g for all matherials

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

References

[1] Miau, T., *et al.*, Journal of Colloid and Interface Science , 15, (2023), 768-777.