Carbon Black-Metal Composite Electrodes for High-Performance Energy Storage Devices

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The current increase in energy demand, primarily obtained from fossil fuels, daily releases enormous amounts of greenhouse gases, contributing to climate change with harmful effects on ecosystems and human health. To mitigate these effects, a shift in energy consumption from traditional fossil fuels to the electrification of energy sectors needs to be made. In this landscape, energy storage emerges as a critical and well-established solution to enhance both the reliability and efficiency of the electrical grid and reduce the effects of variability of renewable energy production [1]. This work aims to develop greener electrified interfaces based on electrodes synthesised using the high-performance conductive porous carbon blacks KETJENBLACK EC-600JD and EC-300 (Figure 1) combined with green dense ionic fluids such as choline chloride-based, type III, Deep Eutectic Solvents (DES) as electrolytes [2]. To enhance the performance of the processed electrodes, the carbon blacks were doped with copper nitrate ($Cu(NO_3)_2$) and lithium nitrate ($LiNO_3$) through an annealing process. The resulting composites were thoroughly characterised (BET, SEM, RAMAN, XRD) and subsequently electrochemically tested (CV and EIS) with the choline chloride : glycerol DES. This testing aimed to evaluate the electrochemical performance and stability of the composites within the DES environment, which is known for its unique properties such as low volatility, high conductivity, and eco-friendliness. The materials characterisation confirmed the successful incorporation and dispersion of metal salts within the carbon matrix. Particularly, BET confirmed an increase in pore diameter enhancing the material properties for electrochemical applications (from 51.35 Å to 80.09 Å for KETJENBLACK EC-600JD blended with $Cu(NO_3)_2$). Electrochemical tests, using a three-electrode configuration, also confirmed an enhanced capacity from 114.74 mF/g to 229.03 mF/g, respectively.

References

[1] B. Dunn, H. Kamath, J.-M. Tarascon, Science 334 (2011) 928–935.
[2] A.T.S.C. Brandão, S. State, R. Costa, P. Potorac, J.A. Vázquez, J. Valcarcel, A.F. Silva, L. Anicai, M. Enachescu, C.M. Pereira, ACS Omega 8 (2023) 18782–18798.

Figures

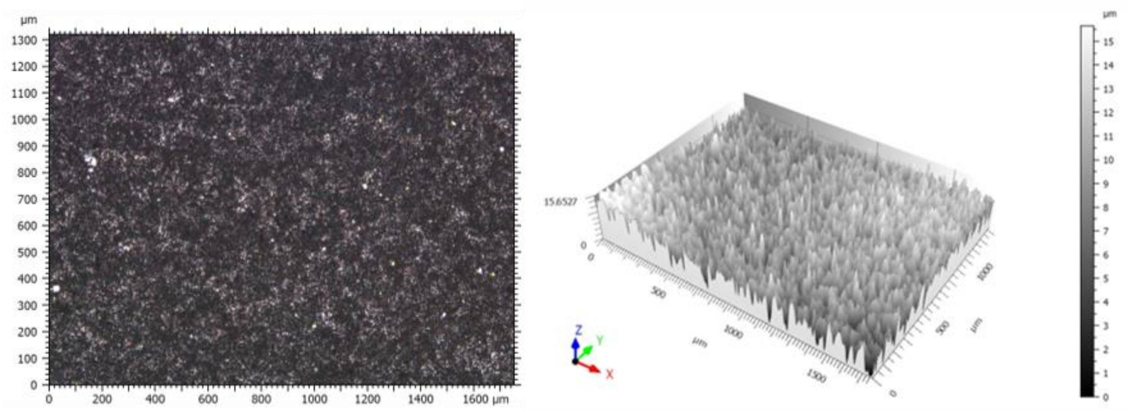

Figure 1: Confocal images in 2D and 3D representation of KETJENBLACK EC-600JD blended with $Cu(NO_3)_2$