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Exploring $LiZnBO_3$ for Electrochemical Energy Storage: A Cost-Effective Borate-Based Electrode

The pursuit of cost-effective and high-performance electrode materials is essential for advancing supercapacitor technologies. Lithium zinc borate ($LiZnBO_3$) presents a compelling solution, offering structural robustness, low density, and electroactive metal centers that enhance charge storage capabilities. In this study, $LiZnBO_3$ was synthesized via a combustion technique and systematically characterized using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). These analyses confirmed the formation of a crystalline borate phase with uniform morphology and well-defined grain boundaries. Electrochemical evaluation in alkaline electrolyte was conducted through cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS). The $LiZnBO_3$ electrode delivered a specific capacitance of 77 F/g at a current density of 1 A/g, demonstrating excellent reversibility, rate capability, and low internal resistance. The enhanced performance is attributed to the synergistic interaction of lithium and zinc ions within the borate matrix, which facilitates rapid electron transport and efficient ion diffusion. These findings establish $LiZnBO_3$ as a promising, environmentally benign electrode material for next-generation supercapacitor applications.

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