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Natural materials to electrochemistry: functional carbon materials for sustainable supercapacitor applications

Abstract:

The development of sustainable energy storage technologies requires the integration of environmentally benign and renewable materials into high-performance electrochemical devices. Among the available options, electrochemical double-layer capacitors (EDLCs), commonly referred to as supercapacitors, have attracted considerable attention due to their high-power density, rapid charge-discharge capability, and long cycle life. However, the performance of EDLCs is critically dependent on the physicochemical properties of the carbon-based electrode materials, including their surface area, pore size distribution, conductivity, and surface functionalities. Lignin, as the second most abundant natural polymer and a by-product of the pulp and paper industry, provides a renewable and underutilized carbon source. Through controlled carbonization and activation processes, lignin can be converted into porous carbon frameworks with tunable textural and chemical properties suitable for electrochemical applications. The presence of heteroatoms in the lignin backbone further enables the introduction of surface functionalities, which may enhance charge storage mechanisms beyond pure double-layer capacitance by contributing pseudocapacitive effects. In this work, lignin-derived carbons were synthesized and evaluated as electrode materials for supercapacitors. Electrochemical testing demonstrated specific capacitances on the order of ~70 F/g in aqueous electrolytes, and high cyclic stability. These findings highlight the potential of lignin-based carbons not only as cost-effective and environmentally friendly materials.MDR infections while minimizing resistance development.

Biography

Xymena Gross is a master's student in Chemical Technology at the Poznań University of Technology. She specialises in applied electrochemistry. She works in an interdisciplinary manner, combining chemistry, green chemistry and energetics science. As a young scientist, she stands out from her peers by regularly publishing her results in scientific journals and presenting them at international conferences.