

## 微波水热 处理对杜仲木基炭材料电化学性能影响研究

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**摘要:** 我国提出“双碳”目标, 加速能源结构调整, 促进了多元储能技术的快速发展。锂离子电池材料的供应面临着可持续性的挑战, 加之安全系数差和制造过程的复杂性, 成本居高不下。因此, 开发多元储能技术, 有及其重要的战略意义。本论文构建微波水热碳化预处理制备多孔活性炭应用于超级电容器和制备硬碳应用于钠离子电池的研究内容, 提供了一种节能、环保、高效的制备方法, 为生物质原料应用于储能领域提供了参考。利用杜仲木材作为生物质前驱体, 磷酸作为活化剂, 通过微波水热预处理与微波热解协同制备了杜仲木基活性炭, 并组装超级电容器测试其电化学性能。杜仲木材 170 °C 条件下微波水热 1 h, 以 800 W 功率微波热解 30 min, 制备的活性炭比表面积最高, 为 2138.3 m<sup>2</sup>/g, 发达的孔隙结构和高比表面积有助于离子的存储和传输, 从而具有更大的比电容和循环稳定性。此外, 在不使用活化剂的情况下, 通过微波水热预处理和高温热解制备了杜仲木基硬碳, 并组装扣式电池测试储钠性能。1300 °C 热解条件下, 比表面积最低, 为 70.87 m<sup>2</sup>/g, 闭孔结构的形成有助于钠离子半电池平台容量的提高。微波水热预处理有助于提高硬碳晶体的无序化程度和层间间距, 使硬碳内部形成更多缺陷, 促进 Na<sup>+</sup> 的传输。此方法制备的硬碳作为钠离子电池负极材料展现出良好的充放电比容量和库伦效率。

## Research on The Effect of Microwave Hydrothermal Pretreatment on Electrochemical Properties of Carbon Materials Based on *Eucommia ulmoides* Oliver Wood

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**Abstract:** The goal of carbon dioxide emission and carbon neutrality was presented in recent years, which accelerated energy restructuring and contributed to the rapid development of diversified energy storage technologies. The supply of lithium-ion battery materials faced sustainability challenges, coupled with poor safety margins and the complexity of the manufacturing process, resulting in high costs. Therefore, the development of multifaceted energy storage technology had the strategic significance. The content of microwave hydrothermal pretreatment to prepare porous activated carbon for application in supercapacitors and hard carbon for application in sodium-ion batteries was researched. This work provided an energy-saving, environmentally friendly and highly efficient preparation method for the application of biomass raw materials in the field of energy storage. The activated carbon was prepared by microwave hydrothermal pretreatment and microwave pyrolysis using *Eucommia ulmoides* oliver wood as biomass precursor and phosphoric acid as an activator. The electrochemical properties were tested by assembling supercapacitors. The highest specific surface area of 2138.3 m<sup>2</sup>/g was obtained by microwave hydrothermal treatment at 170 °C for 1 h and microwave pyrolysis at 800 W for 30 min. The well-developed pore

structure and the high specific surface area contributed to the storage and transport of ions, which results in a larger specific capacitance and cycling stability. In addition, the hard carbon was prepared by microwave hydrothermal pretreatment and high-temperature pyrolysis without the use of activator. Snap batteries were assembled to test the sodium storage performance. The lowest specific surface area of 70.87 m<sup>2</sup>/g was observed under pyrolysis condition at 1300 °C. The formation of the closed pore structure contributed to the increase of the platform capacity of the sodium-ion half batteries. The microwave hydrothermal pretreatment helped to increase the degree of disorder and interlayer spacing of the hard carbon crystals, which resulted in the formation of more defects inside the hard carbon and promoted the transport of Na<sup>+</sup>. The hard carbon prepared by this method exhibited good charge/discharge specific capacity and coulombic efficiency as an anode material for sodium-ion batteries.