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Project title: Laser-Induced Lignin Carbonisation: A Green Alternative for Batteries and Supercapacitors

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Abstract (approx. 200 words)**:**
Lignin, an abundant and renewable biomass component, offers a sustainable carbon source for advanced energy storage applications. This work investigates the conversion of lignin into carbon materials for use in rechargeable batteries and supercapacitors, with a particular emphasis on sustainable production routes. Although carbon materials are widely utilised as electrode components and conductive additives, their conventional production remains highly dependent on fossil resources. To address this challenge, laser-induced carbonisation (LIC) of lignin was employed as a green alternative to traditional pyrolysis. This technique enables the direct conversion of lignin into high-quality graphene films at room temperature under ambient air, substantially reducing chemical consumption, waste generation, and energy demand compared to both pyrolysis and graphite mining. The resulting graphene films demonstrate excellent electrical conductivity and mechanical stability, rendering them suitable for printed micro-supercapacitors as well as binder-free, current-collector-free electrodes in secondary batteries. Considering the global carbon materials market size (€881 billion in 2023) and the growing emphasis on sustainable production, LIC from lignin represents a timely and environmentally friendly strategy to meet the rising demand for carbon materials in energy storage technologies.

Key words: Lignin, Graphene-like carbon materials, Laser-induced carbonisation, Supercapacitors, Li-ion batteries