
Laser-Induced Graphene on Bacterial Cellulose for Electrochemical Sensing

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The development of disposable electrochemical sensors with enhanced scalability and environmental compatibility requires innovative strategies. Laser-induced graphene (LIG) has emerged as a promising technique, enabling the direct conversion of carbon-rich substrates into conductive graphene using a CO₂ laser under ambient conditions. Bacterial cellulose (BC), with its nanofibrillar structure, high crystallinity, and excellent mechanical strength, is an attractive substrate for such applications. However, its predominantly aliphatic composition causes thermal degradation above 330 °C, releasing volatiles that hinder graphene formation. To overcome this, BC was pre-treated with a sodium-based fire-retardant solution. Upon laser exposure, the additive undergoes endothermic decomposition, promoting localized graphitization and allowing effective LIG synthesis without damaging the substrate. This solvent-free approach produced porous, graphitized electrodes with high structural uniformity and low measurement variation (3.41% between measurements, 1.09% between devices). Sensor performance was validated through acetaminophen detection, with detection and quantification limits of 1.65 and 5.00 µmol L⁻¹, and recovery rates of 93–114% in urine samples. This is the first report of BC as a viable substrate for LIG-based sensing, offering a scalable and sustainable platform for future electrochemical devices.

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