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Abstract

Eucalyptus Biochar as a Sustainable Nanomaterial for Electrochemical Sensors †

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Abstract: Carbonaceous-based nanomaterials (C-NMs) are the pillar of myriad sensing and catalytic electrochemical applications. In this field, the search for environmentally sustainable C-NMs from renewable sources became a duty in the development of nano-sensors. Herein, water-soluble carbon nanofibers (CF) were produced from eucalyptus scraps-based biochar (BH) through an ultrasound treatment, assisted by sodium cholate used as a stabilizing agent. Noteworthy, thanks to the use of the bio-stabilizing agent, the nanofibers were dispersed in water avoiding the use of organic solvents. The BH-CF was investigated as sensing material onto commercial screen-printed electrodes via drop-casting (BH-SPE) and as thin-film fully integrated into a lab-made flexible electrode. The thin film was produced via BH-CF vacuum filtration followed by the film transferring to a thermo-adhesive plastic substrate through thermal lamination. This approach gave rise to a conductive BH-CF film (BH-Film) easily embodied in a lab-made electrode produced with office-grade instrumentation (i.e., craft-cutter machine, thermal laminator) and materials (i.e., laminating pouches, stencil). The BH-CF amount was optimized and the resulting film morphologically characterized, then, the electrochemical performances were studied. The BH-CF electrochemical features were investigated towards a broad range of analytes containing phenol moieties, discrimination between orto- and mono-phenolic structures were achieved for all the studied compounds. As proof of applicability, the BH-CF-based sensors were challenged for simultaneous determination of mono-phenols and ortho-diphenols in olive oil extracts. LODs $\leq$ 0.5 µM and $\leq$ 3.8 µM were obtained for hydroxytyrosol (o-diphenol reference standard) and Tyrosol (m-phenols reference standard), respectively. Moreover, a high inter-sensors precision (RSD calibration-slopes $\leq$ 7%, n = 3) and quantitative recoveries in sample analysis (recoveries 91–111%, RSD $\leq$ 6%) were obtained. Here, a solvent-free strategy to obtain water-soluble BH-CF was proposed, and their usability to sensor fabrication and modification proved. This work demonstrated as cost-effective and sustainable renewable sources, rationally used, can lead to obtain useful nanomaterials.

Keywords: biochar; sensor; nanomaterial

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