Expanding circularity of plastic and biochar materials by developing alternative low environmental footprint sensors

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Flexible screen-printed technology combined with the use of nano/materials coating improving electrode functionalities boosted the manufacturing of highly sensitive electrochemical sensors addressing the need for fast and easy-to-handle tests in different application fields. However, due to the large-scale production and disposable and single-use nature of these devices, their environmental footprint should be taken into careful consideration. Herein, the innovative reuse of post-consumer plastics as an alternative substrate coupled with biochar as an environmentally friendly and cost-effective modifier are described as sustainable alternatives to produce robust electrochemical sensors. The good printability of reused plastic with graphite inks despite chemical heterogeneity, different crystallinity, and surface roughness was demonstrated using Atomic Force Microscopy and Attenuated Total Reflection Fourier Transform Infrared spectroscopy.

Functionalization with a biochar-multilayer system enabled the fabrication of highly performing electrochemical sensors tested for nitrites detection in water having a limit of detection and limit of quantification of 3.3 nM and 10.3 nM, respectively, with a linear range spanning from 0.01 to 500 µM, and good reproducibility (RSD% 8%). This work lays a foundation for repurposing end-of-life plastics for the electronics industry and presents a customizable reuse strategy aimed to reduce waste and leakage into the natural environment.