Fabrication of a “Green” and Low–Cost Screen–Printed Graphene Sensor and Its Application to the Determination of Caffeine by Adsorptive Stripping Voltammetry

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This work reports the development of low–cost graphene–based screen–printed sensors using a “green” fabrication procedure. Three–electrode sensors featuring carbon working and counter electrodes and a Ag reference electrode were fabricated by screen–printing on flexible polymer film. Graphene suspension was prepared following a simple, fast and environment–friendly method of solvent exfoliation of graphite in N–methyl pyrrolidone (NMP). Graphene was further dispersed in Nafion and the solution was used to drop–coat the working electrode of the sensor. The modified electrode was characterized using Raman spectroscopy, scanning electron microscopy (SEM) and electrochemical impedance spectroscopy (EIS). The graphene/Nafion modified sensors were used to determine caffeine by anodic adsorptive stripping voltammetry. The procedure consists of a short adsorptive preconcentration step of caffeine on the graphene working electrode followed by an anodic voltammetric scan in the differential pulse (DP) mode. The oxidation current of caffeine is related to its concentration in the sample. High sensitivity was achieved due to the preconcentration step of the target compound on the working electrode. The limit of detection (LOD) for caffeine was 0.021 $\mu\text{mol L}^{-1}$ and the % relative standard deviation ($n=8$) was 2.0 %. The sensors were applied to the determination of caffeine in coffee and beverage samples.

Keywords: caffeine; graphene; Nafion; adsorptive stripping voltammetry; coffee; beverages

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