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A simple system for comprehensive monitoring of o-chlorophenol

The o-chlorophenol is a typical chlorophenol that is extensively used in synthesizing fungicides, preservatives, herbicides, and insecticides. As a highly toxic, carcinogenic, and mutagenic substance that poses serious ecological threats, o-chlorophenol has been listed as a priority pollutant by the US Environment Protection Agency and European Union. However, the chemical and biological tests that are typically used for the quantification and toxicity assessment of o-chlorophenol are independent and based on various instruments and techniques. Therefore, the development of a simple and reliable method to detect the o-chlorophenol in the environment is urgently needed. In this study, an electrochemical system consisting of an electrochemical workstation, the functionalized carbon nanotubes/rhodamine B modified glass carbon electrode (f-CNTs/RhB/GCE), a Pt wire, and the saturated calomel electrode (SCE) was developed (Fig. 1). This system was primarily characterized by the integration of both physicochemical and biological monitoring procedures that had a synergistic effect between the f-CNTs and RhB.

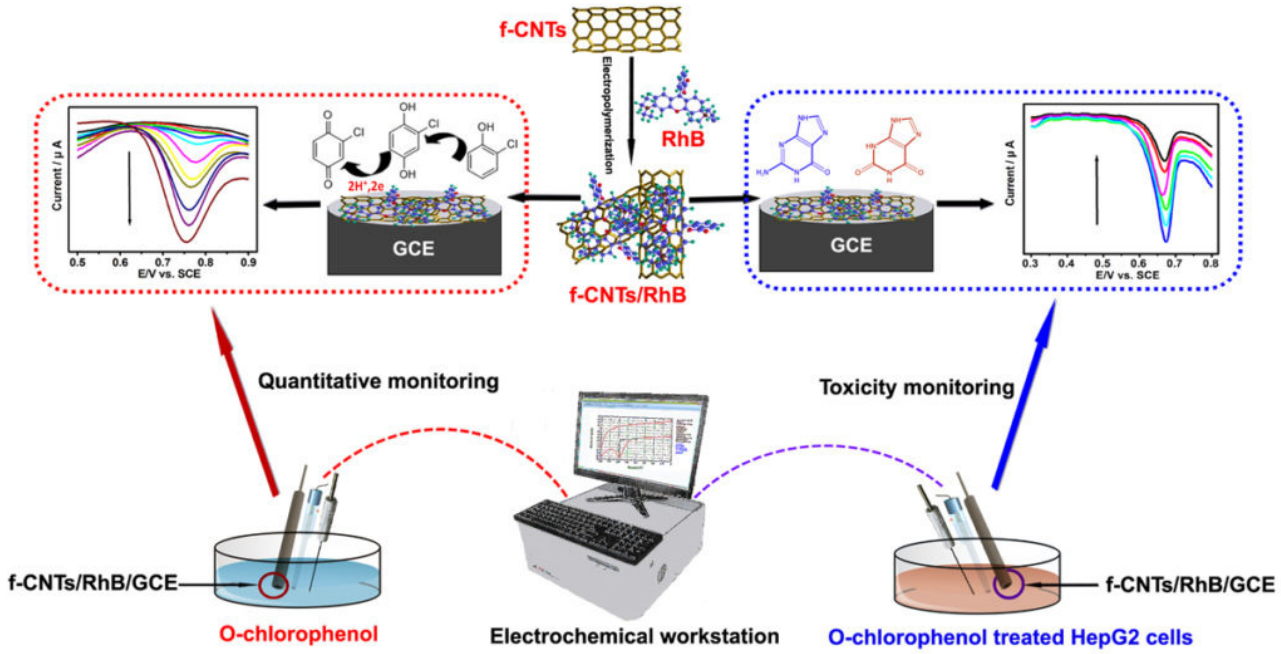

Fig. 1. Schematic diagram of the electrochemical system based on f-CNTs/RhB for quantitative determination and toxicity evaluation of o-chlorophenol.

The peak current (I_p) of o-chlorophenol was linear with its concentration (c) ranging from 0.05–125.0 μM. The linear regression equation was expressed as: I_p (μA) = 0.160 c (μM) + 1.098 (R^2 = 0.996). The limit of detection (LOD) was 0.028 μM(S/N = 3). The proposed system has a wider linear range and lower LOD, indicating the higher sensitivity in the quantitative monitoring of OCP than the other electrochemical sensors. The applicability of the f-CNTs/RhB/GCE based electrochemical system for o-chlorophenol detection in actual water samples was also investigated. The recoveries in the range of 96.8–104.6% suggested the excellent reliability and application potential of this electrochemical system.

Meanwhile, an enhanced voltammetric signal that was caused by the guanine/xanthine of human hepatoma (HepG2) cells was detected by the electrochemical system . The cell growth curve described by the signal was consistent with that of the viable count method, indicating that the electrochemical system could be used to study the cell viability and the cell growth process. The toxicity of o-chlorophenol to HepG2 cells was assessed using the proposed system. The linear regression equation between the cytotoxicity (Y) and the logarithm of concentration (X) was $Y = 53.41\ X - 94.58$ ($R^2 = 0.995$). The IC_{50} value was 512.86 μM, which was lower than that of the conventional 3-(4,5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide (MTT) assay (616.60 μM). This demonstrated that the proposed electrochemical system was more sensitive in monitoring the toxicity of OCP.

This study provides a fast, label-free, and low-cost platform for the comprehensive assessment of o-chlorophenol. This is highly beneficial for simplifying the environmental monitoring process.

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