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3D Paper-based Electrochemical Device Using Graphite Screen Printed Electrode Modified with MIP for Serotonin Detection

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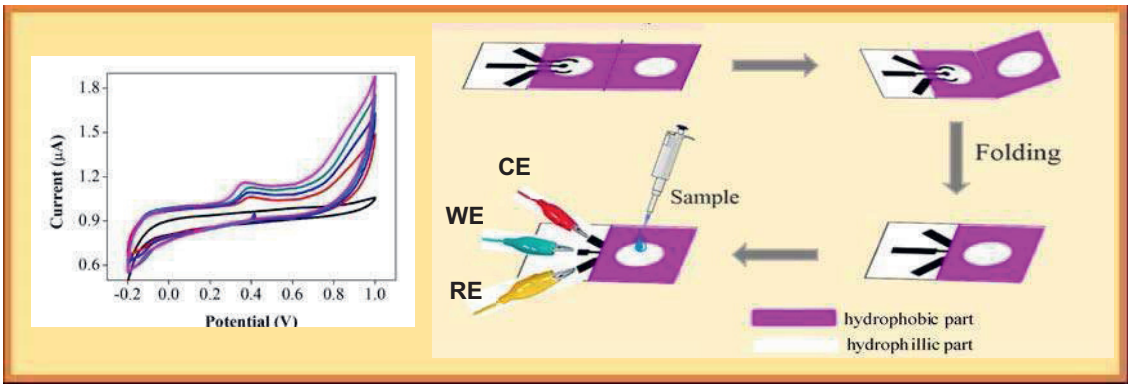
Abstract:
This paper demonstrates a three-dimensional electrochemical paper-based analytical device (3DePAD) for highly sensitive and selective determination of serotonin. The device was fabricated by alkyl ketene dimer (AKD)-inkjet printing of a circular hydrophobic zone on filter paper for sensing in aqueous samples. This was followed by screen-printing electrodes onto the paper, which was folded underneath hydrophobic zone. A self-assembled three-electrode system, comprising a graphite paste modified with nanoparticles coated with molecularly imprinted polymer (MIP) was fabricated on the patterned paper by screen printing through the pre-designed transparent film slit. A novel core-shell composite of gold-coated magnetite (Fe_3O_4@Au) and SiO_2 MIP was synthesized by sol–gel method using serotonin as template molecule, phenyl trimethoxysilane (PTMOS) as monomer, and tetramethoxysilane (TMOS) as cross linker. The three electrodes of modified graphite electrodes (Fe_3O_4@Au@SiO_2-MIP/GFE) on the layout paper served as the working electrode, the reference electrode, and the counter electrode, respectively. The fabricated 3D-ePAD was applied to detect serotonin by cyclic voltammetry in 0.1 M phosphate buffer, pH=8.0. Results indicate that the developed device is highly sensitive to serotonin. The oxidation of serotonin was found at +0.34 V. The anodic peak currents of serotonin provides the linearity ranged from 0.5 to 10 µM ($y = 0.0224x + 0.0722$, $r^2 = 0.994$). These results demonstrate that our 3D-ePAD have many advantages such as an easy to-use, inexpensive, sensitive, and high selective for serotonin determination.



Key words: Serotonin, 3D-electrochemical paper-based analytical device (3D-ePAD), MIP, goldcoated magnetite