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Mini review

Disposable electrochemical sensors: A mini review

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ABSTRACT

This review presents some of the recent development in disposable sensors with an emphasis on preanodized and mediator-modified screen printed carbon electrodes.

Contents

1. Introduction

Screen-printing technology represents a well-established technique for the fabrication of electrochemical sensors with high sensitivity and selectivity [1,2]. It has been successfully extended from rigid substrates to flexible materials like paper, stress ball, wearable cloth etc., to further widen the application scope [3,4]. Screen-printed electrode (SPE) has revolutionized the field not only by reducing the manufacturing cost but also by making possible the production of a variety of electrodes in a highly reproducible manner. It allows modification to be performed in terms of design such as single strip 3-electrode system, ultramicroelectrode, electrode array and ring electrode. The ease of surface grafting using both chemical and electrochemical techniques with catalytically selective chemicals further makes more versatile applications. Herein, we highlight some of the important advances being achieved on disposable screen printed electrode platform using oxygen functionalities and edge plane like sites and in combination with some chemical modification.

2. Preanodized screen printed carbon electrode (SPCE*)

The emergence of several carbon materials, in particular carbon nanotube (CNT) and graphene, has considerably changed the scope of carbon-based electrodes in electroanalysis [5]. Notably, Compton's group showed that the enhanced electrocatalytic properties of CNT towards several target molecules to be originating from the defect/edge plane like sites by comparing it with edge-plane pyrolytic graphite (EPPG) electrodes. They also examined the role of impurities present in/on CNT and recommended the use of stable EPPG electrodes instead of CNT to get unambiguous results and for the simplicity of measurement [5,6]. Our group earlier demonstrated that such defect/edge plane like sites and oxygen functionalities can be created on SPCE surface through a simple preanodization process (Fig. 1A) [7]. From the economic view point and ease of modification, the use of preanodized SPCE (SPCE*) is highly suitable and can be exploited for the routine sensing like CNT and EPPG electrodes. The preparation of SPCE* involves anodization at an applied potential of 2.0 V vs. Ag/AgCl for a suitable time either in 0.1 M phosphate buffer solution (PBS), H_2SO_4, or NaOH as required under stirred condition. The characterization of the modified electrode was usually studied using XPS, Raman, and SEM analysis to confirm the formation of edge plane like sites and surface oxygen functional groups.

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A comparison on the role of oxygen functionalities and edge plane sites created through electrochemical preanodization process and oxygen plasma treated SPCE (OSPCE) was studied by Prasad et al. [8]. Interestingly, the surface characterization using XPS showed that a variety of oxygen functionalities can indeed be created on the surface using both techniques. The Raman spectra for SPCE* and OSPCE exhibited a significant difference in their D band intensities, which is indicative of defect/edge plane like sites. Consequently, a higher reduction in the overpotential for ascorbic acid was observed at SPCE* when compared to OSPCE and resulted in a well separation of ascorbic acid oxidation

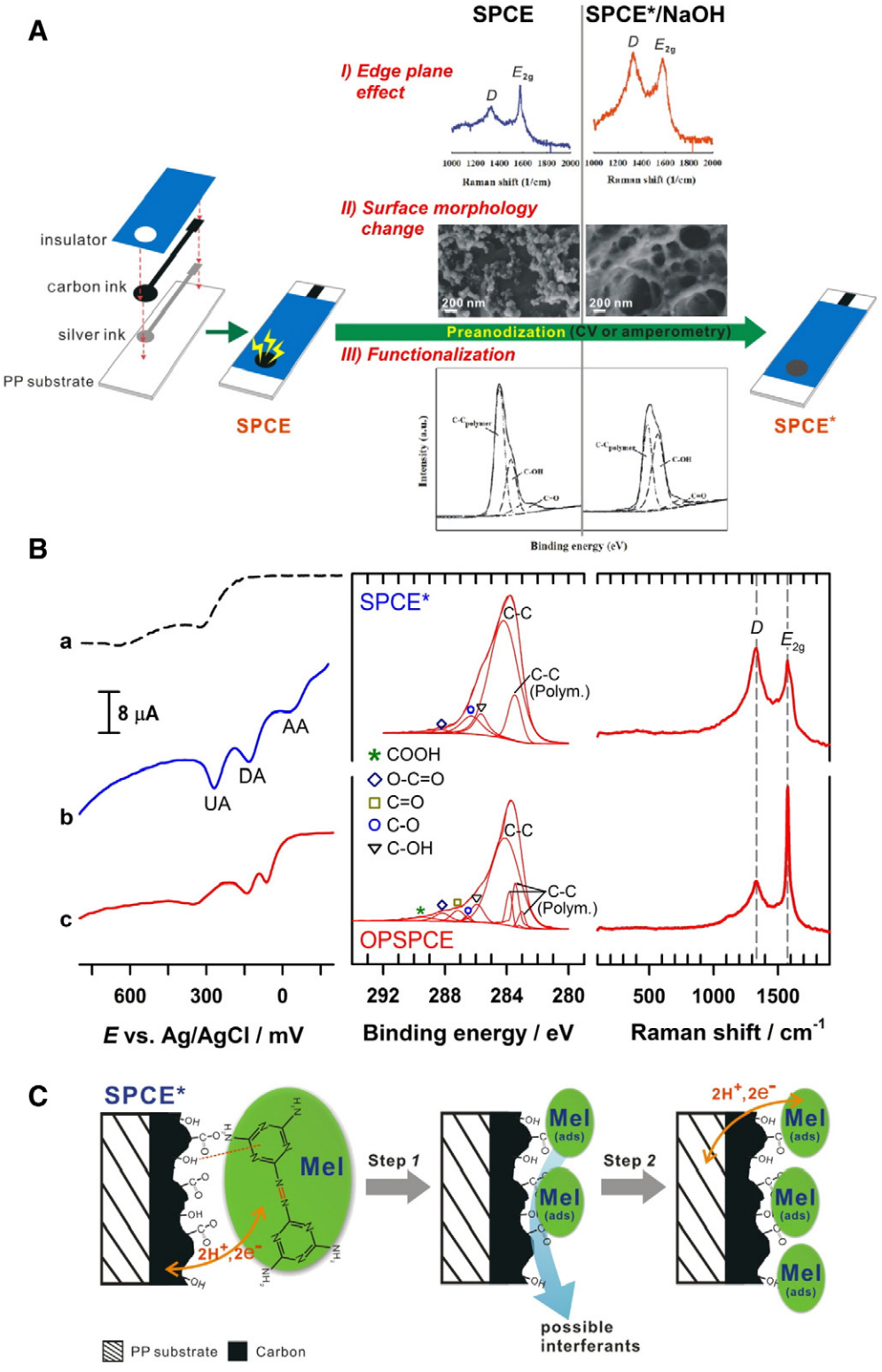

Fig. 1. A) Illustration of the preanodization process at SPCE. B) Linear scan voltammograms at a) SPCE, b) SPCE*, and c) OPSPCE for 2 mM ascorbic acid (AA), 500 μM dopamine (DA), and 1 mM uric acid (UA) at a scan rate of 10 mV/s in 0.1 M PBS (pH = 7.4) and Raman and XPS spectra of SPCE* and OPSPCE. C) Schematic diagram of the electrochemical detection of melamine consisting the preconcentration and medium-exchange steps by using SPCE*.