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Rapid Selective Detection of Ascorbic Acid Using Graphene-Based Microfluidic Platform

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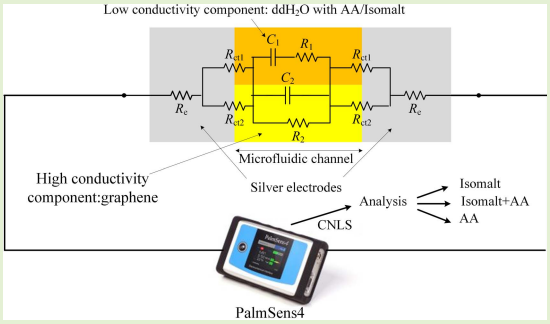
***Abstract*—In this paper, we present a compact microfluidic platform for selective detection of ascorbic acid. The microfluidic chip was fabricated by xurography technique with microfluidic channel placed between the silver electrodes. To increase the conductivity of the platform and enhance electron transfer process, a graphene sheet was deposited in the gap between the electrodes. The suspension of tablets with ascorbic acid and a mixture of ascorbic acid and isomalt, a sugar substitute, were injected in the microfluidic channel. Measuring electrical parameters at the silver contacts, it was possible to successfully differentiate ascorbic acid from isomalt. The sensing mechanism of the developed microfluidic platform is based on the increase of the overall conductivity with the increase of the concentration of ascorbic acid, resulting in the decrease of the resistive parameters and increase of the capacitive parameters of the proposed equivalent electrical circuit. The addition of graphene was found to improve the response linearity by 5.28% and lower the limit of detection and quantification by 12%, compared to the reference structure without graphene.**



***Index Terms*—Microfluidics, graphene, ascorbic acid, impedance spectroscopy.**

I. Introduction

NUTRIONAL supplements have been increasingly popular in recent decades. The emerging field of „nutraceuticals“ [1] emphasizes the importance of nutrition and dietary supplements, not only as an essential factor for prevention of diseases and maintaining good health but also as a way to treat various pathological conditions – alone or in combination with drugs. Ascorbic acid (AA) is a natural organic acid that is widely present in fruits. The AA content is also considered as an indicator of the freshness of the fruits. Since the human body does not produce AA, it is essential to have adequate AA intake through food, drugs or dietary supplements (recommended dietary allowance is ∼120 mg/day). AA can be added in pharmaceutical formulations in order to prevent or cure some diseases, e.g., common cold and hypohemia [2].

The conventional techniques for the detection of AA are chromatography [3], spectrophotometry [4], and fluorometry [5]. It has been demonstrated that the liquid chromatography can also be coupled with electrochemical methods to determine the amount of AA in real samples such as oranges and apples, pharmaceutical preparations, and human blood serum [6]. Some recent approaches for AA detection are based on optical fiber sensors [7], [8]. A Ge-doped photosensitive optical fiber demonstrated a wide linear range of detection from 1 μM to 1 mM [7]. Moreover, a localized surface plasmon resonance based AA sensor exhibited good chemical and mechanical behavior [8]. Despite the fact that optical-based approaches are promising in terms of the sensitivity and reliability in AA detection, these methods require costly equipment such as fusion splicers and spectrophotometers,

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