Improving sensitivity of organic electrochemical transistor with modified PEDOT-functionalized gate electrodes

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Abstract

Organic electrochemical transistors have emerged as a solid platform for sensing biologically relevant species including proteins [1], nucleic acids [2], metabolites [3] and pathogens [4]. The presence of the biochemical events at the gate electrode interface endows unique sensitivities compared to classical electrochemical sensors due to the signal amplification at the organic channel [5]. Despite the continuous effort has been devoted to enhance the channel properties, the gate electrode plays a critical role to effectively transduce the biochemical binding event in a shift of the effective potential that ultimately lead to the channel doping/dedoping. One strategy to amplify the signal generated by the biochemical event is to utilize more sensitive material as a gate electrodes with nanocomposites of conjugated polymers and 2D materials [6].

In this study, organic channel based on poly(3,4-ethylenedioxythiophene):poly(styrene sulfonic acid) (PEDOT:PSS) with different gate electrodes including PEDOT:PSS:MXene, PEDOT:PSS:GrapheneOxide (GO), and PEDOTOH:ClO_4 were used as electrochemical sensor for uric acid, ascorbic acid, and dopamine. We found that the device with PEDOT:PSS:MXene gate electrode characterized at the gate voltage of 0.2V shows the highest sensitivity. The gate operation condition was determined by performing cyclic voltammetry measurements. The detection limit of the transistors was obtained about 100 nm which is better than a conventional electrochemical sensors. Our results suggest that PEDOT:PSS:MXene gated transistors could be used to sense low abundance biological species such as SARS-CoV-2.

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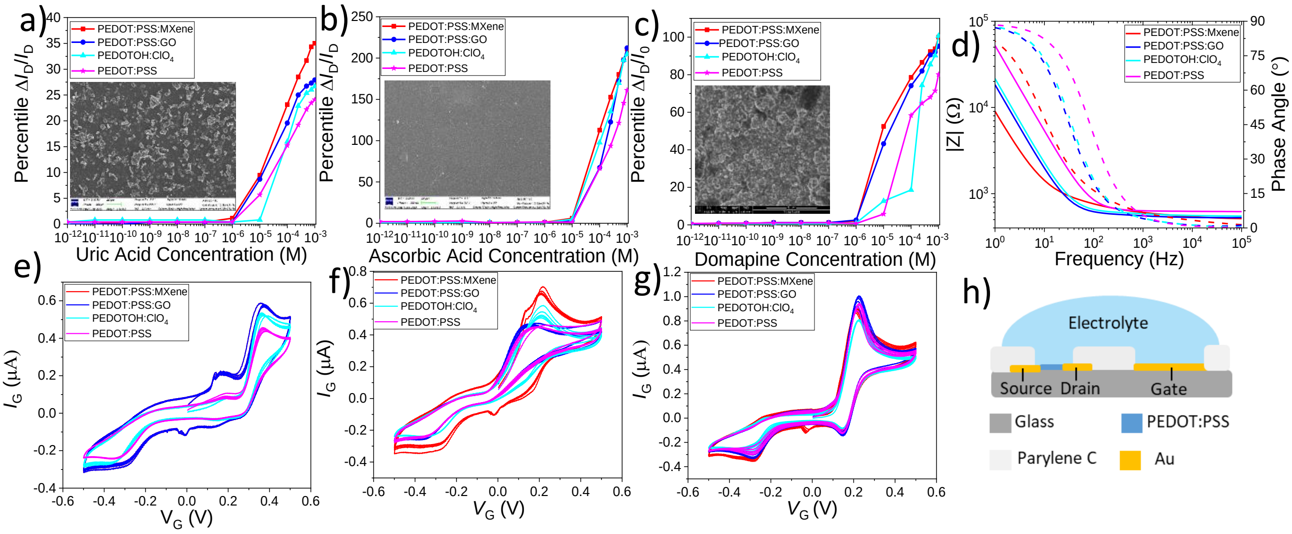

Figure 1. Sensitivity of transistors measured with a) uric acid, b) ascorbic acid, and c) dopamine for different gate electrodes, and d) their impedance spectra. Cyclic voltammetry measurements determines the optimum transistor operation condition for e) uric acid, f) ascorbic acid, and g) dopamine. h) Device schematic