FLEXIBLE ION-SELECTIVE BIOSENSORS FOR SWEAT ANALYSIS

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Flexible biosensor technologies are significant to realize continuous and real-time monitoring of people's physical situation. Sampling biomolecules and ions in human sweat paves a way for non-invasive state monitoring, bringing enormous potential applications in healthcare and sports. As one of the prime candidates, the organic electrochemical transistor (OECT) has attracted a lot of attention in recent years for its high sensitivity and low operating voltages (<1V) in aqueous solutions[1].

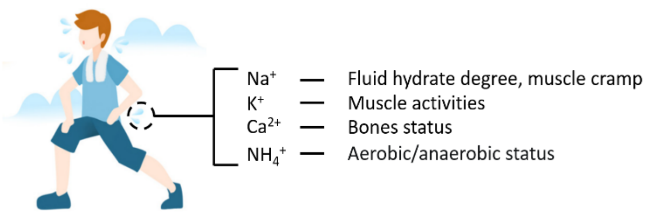


FIGURE 1 – THE MAJOR IONS IN SWEAT AND THEIR RELATED PHYSICAL STATES

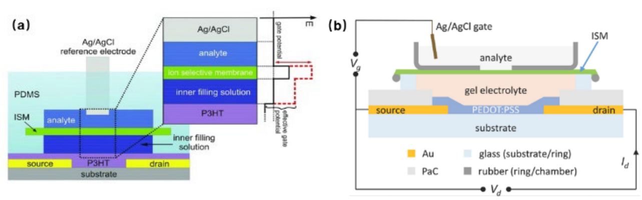
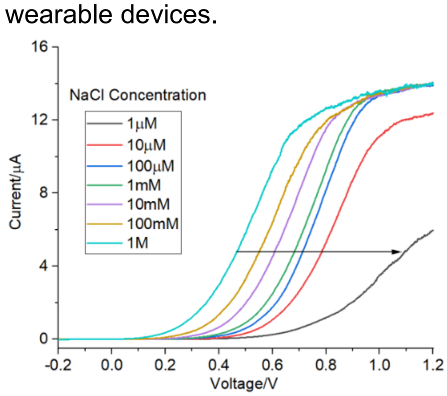


Figure 2– Typical designs of (a) Na+ and (b) K+ selective membrane in OECT devices

In practical applications, it is critical to screen multiple target biomarkers simultaneously due to the complexity of sweat content. The major ions in sweat and their related physical states[2] are shown in Fig.1. High selectivity to specific biomarkers in complex solutions is required to ensure the accuracy of measurements. For biomacromolecules, target biomarkers are managed to the state that is reactive at the gate. For example, glucose is degraded by the catalytic enzyme to H_2O_2 which can occur an oxidation-reduction reaction at the Pt gate; protein is captured on the surface of the gate electrode by an antibody and they together attribute to the electrochemical reaction of the OECT devices. The selective properties of enzymes and antibodies help to separate the target biomarkers and realize the high selectivity performance of the OECT device. These methods are difficult to realize high selective ions detection. The ions are not supposed to participate in reaction at the gate and are difficult to capture due to their tiny radii. In previous works, ion-selective membranes (ISM) which only translate target ions are commonly used to fabricate ion-selective OECT devices (IS-OECTs). The inner solution[3] or gel electrolyte[4] is also introduced to enhance the signal, as shown in Fig.2. However, the presence of ion-selective membranes and inner electrolytes complicates the fabrication of OECT devices, bringing difficulties to designing small and wearable devices.



Here, we explore a two-electrode ion-selective OECT device based on an optimized Na^+ ISM design that can enhance the signal by integrating gate and drain electrodes into one electrode. This device is flexible, wearable, reliable, and shows a sensitivity of 61.5 mV/dec in the 10^{-5}-1M Na^+ concentration range, as shown in Fig.3. This simplified design can also be applied for K^+, Ca^{2+}, NH_4^+ detection by changing the ISM. It is also supposed to have advantages in fabricating integrated wearable sensor arrays for multiplexed sweat analysis.

Figure 3 – Ion-selective OECT detection of NaCl concentration

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