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HIGH-PERFORMANCE ION-SELECTIVE ORGANIC ELECTROCHEMICAL TRANSISTORS FOR THE DETERMINATION OF POTASSIUM IN CLINICAL SAMPLES

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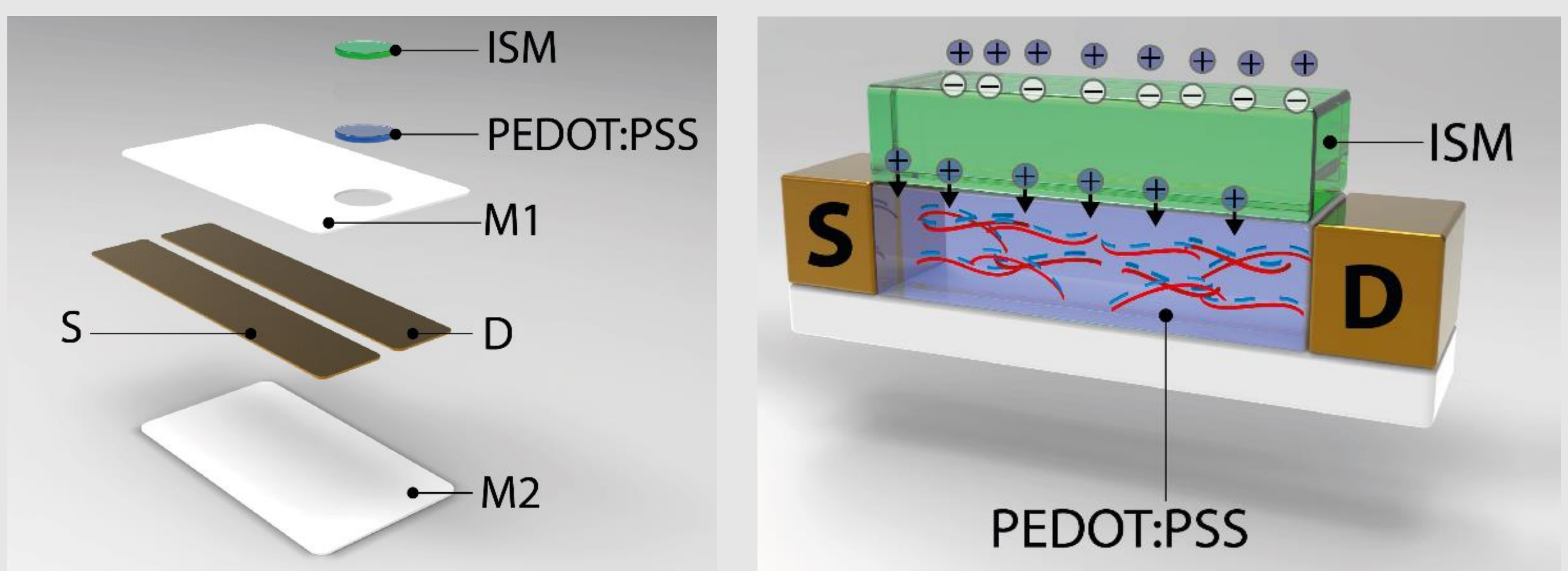
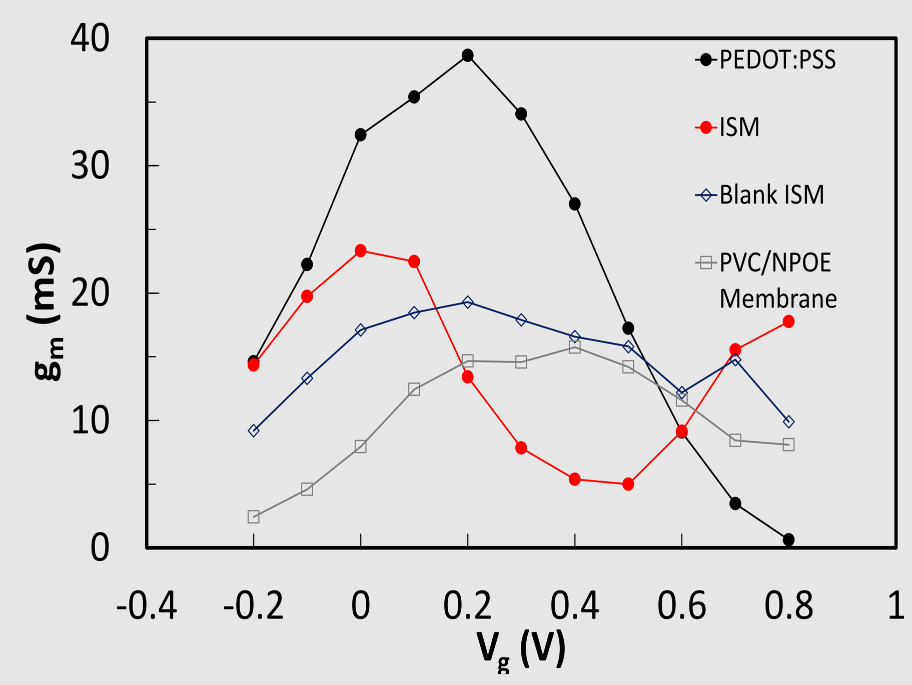
INTRODUCTION

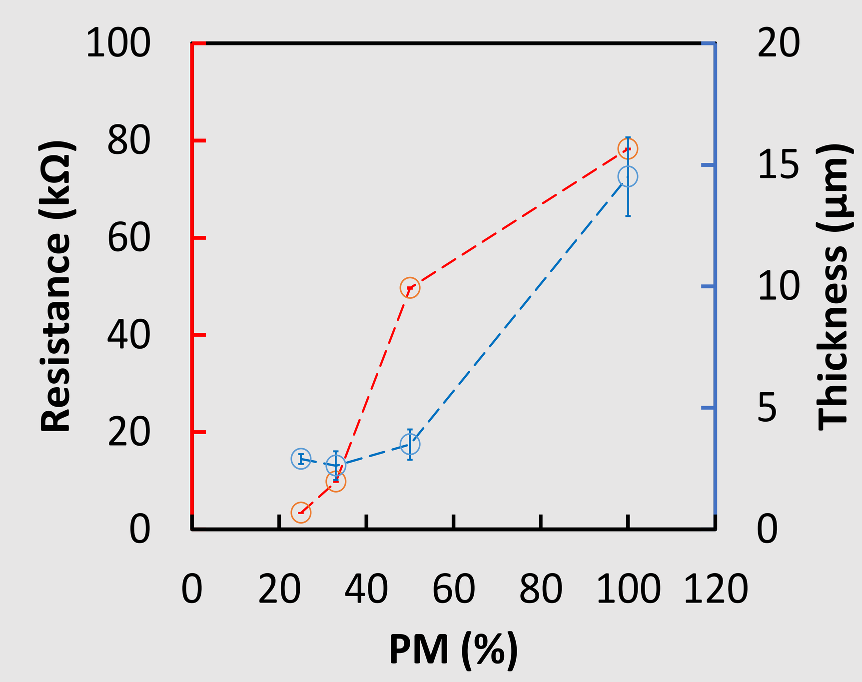
Ion determination in clinical samples represents a major analytical problem since it requires accurate detection of small concentration changes at narrow linear ranges. This analytical challenge can be hardly tackled by any of the existing analytical techniques. In the last decades, organic electrochemical transistors (OECTs) were proposed as ideal alternatives due to their high-amplification capacities. Here, a novel ion-selective organic electrochemical transistor (IS-OECT) with outstanding analytical performance is presented. Combination of thick-film technology[2] with suitable optimization of the ion-selective membrane (ISM) provides high performance and simple manufacturing approach. The excellent sensitivity and selectivity obtained under optimal conditions allow the detection of low K^+ concentrations in high saline concentrations. The sensors are built on a low-cost, simple paper-based platform and using an easily scalable direct printing approach. Therefore, these IS-OCET offer great promise for new decentralized ion-sensing platforms.

SENSOR FABRICATION AND CHARACTERIZATION



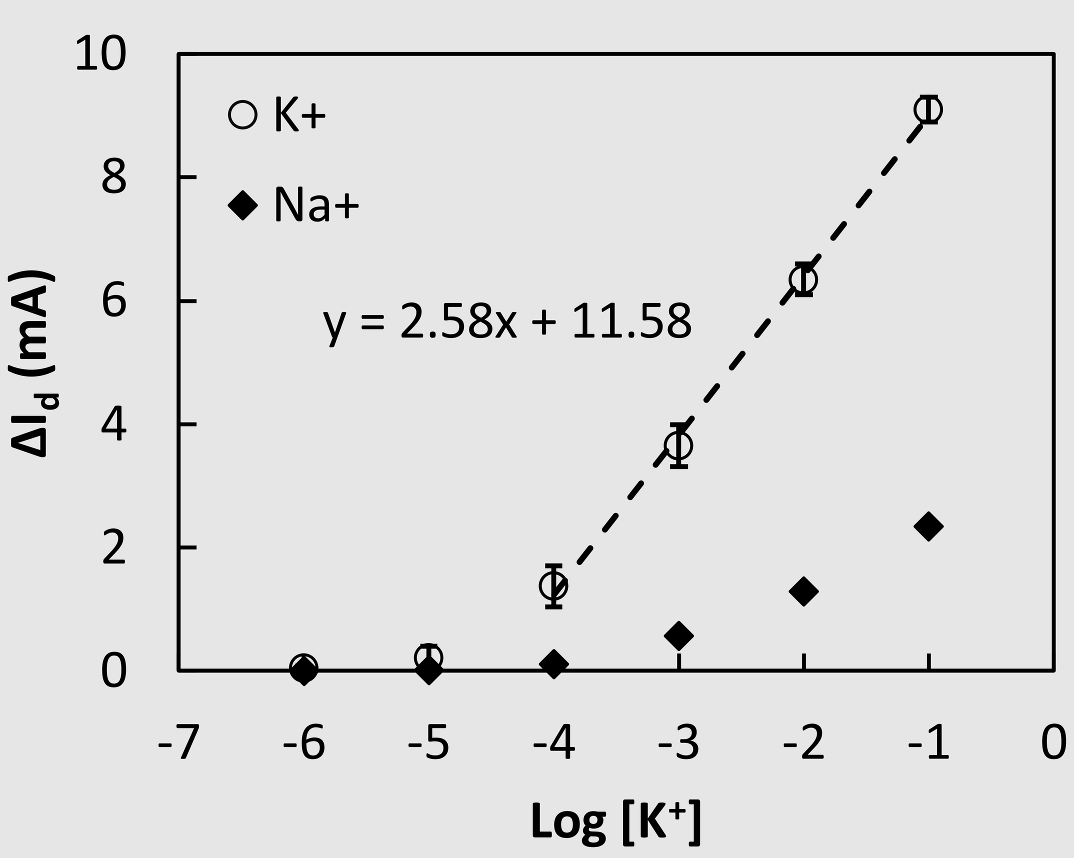
1. Source (S) and drain (D) electrodes: gold sputtering (100 nm).
2. Channel: conducting polymer cast (PEDOT:PSS)
3. Paper mask to cover the electrodes (M1-M2).
4. Ion-selective membrane: dilution of the polymeric matrix (PM/3).



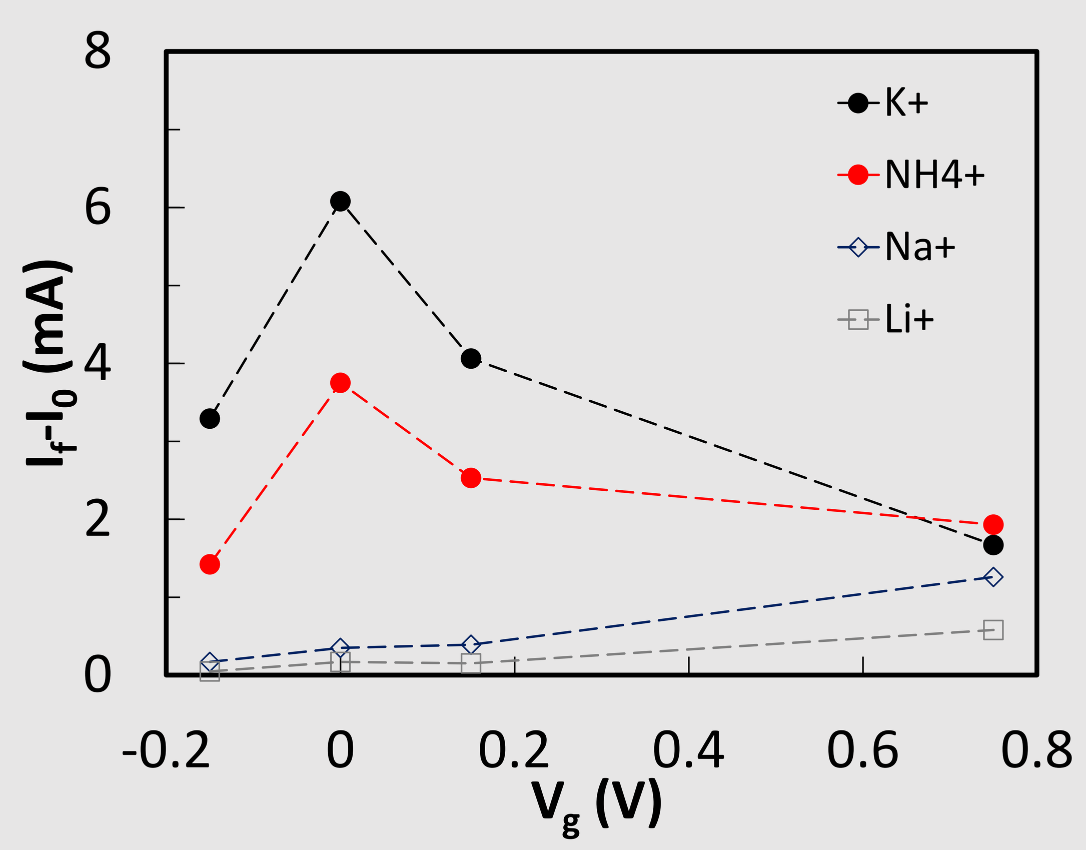


- ISM thickness dilution reduces sharply the electrical permittivity and resistance.
- High amplification characteristics with and without ISM membrane.

RESULTS AND DISCUSSIONS



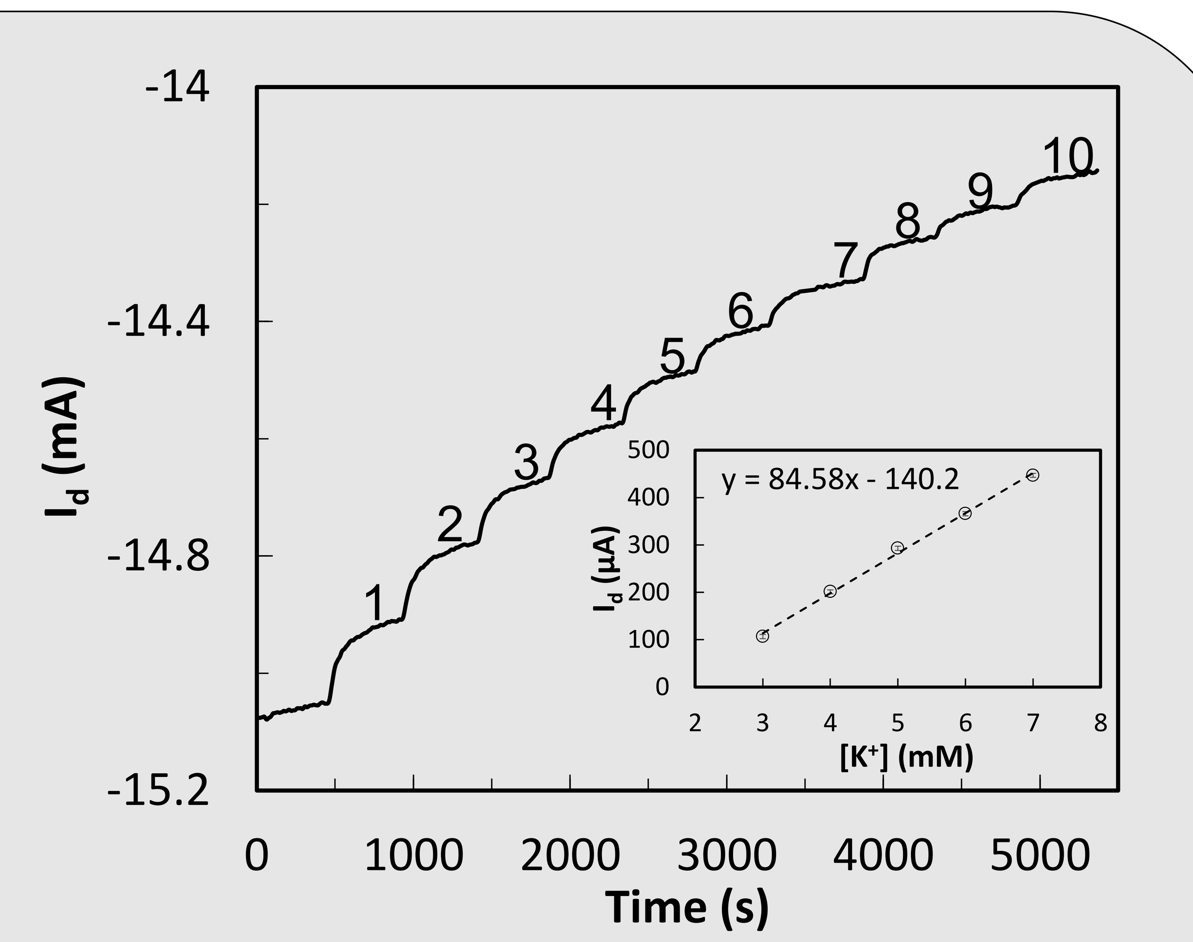
- Optimum sensitivity obtained for an IS-OECT[3].



- Selectivity dependence with the applied gate voltage (V_g):

  Low V_g → Ion-ionophore affinity.

  High V_g → Cation lipophilicity.



- High precision detection in artificial serum.
- Changes in concentration down to 0.05 mM could be detected.

CONCLUSIONS

✓ A robust, reproducible and affordable paper-based sensor.

✓ Sensor analytical response depends on the applied gate voltage.

✓ The outstanding sensitivity is improved by more than 20 times compared to previous works.

✓ Sensors can discriminate with good precision mM additions in a complex sample matrix.

FUTURE WORK

- Multiplex ion sensing using different ISM and a single gate electrode.
- Further optimizations can help to improve the limits of detection.
- Simplify the instrumental setup by removing the gate electrode.

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