Supplementary Information (ESI)

S1. Experimental Data and Replicates

Time measurements were recorded for varying ionic concentrations. Each condition was measured with five independent replicates (n = 5).

Table S1. Raw experimental data (time in seconds)

Concentration (M)	Replicate 1	Replicate 2	Replicate 3	Replicate 4	Replicate 5
0.01	16	16	18	17	17
0.03	8	11	14	12	12
0.04	12	15	8	10	12
0.05	5	6	8	5	6
0.10	4	5	6	4	4
0.15	4	5	5	3	4

S2. Processed Data

Mean values were calculated from the five replicates for each concentration.

Table S2. Averaged data

Concentration (M)	Time (s)
0.01	16.8
0.03	11.4
0.04	11.4
0.05	6.0
0.10	4.6
0.15	4.2

S3. Statistical Analysis

Standard deviation (SD) was calculated to assess variability.

Table S3. Mean and standard deviation

Concentration (M)	Mean Time (s)	Standard Deviation (s)
0.01	16.8	0.84
0.03	11.4	2.19
0.04	11.4	2.41
0.05	6.0	1.22
0.10	4.6	0.89
0.15	4.2	0.84

S4. Observed Trends

A decrease in time was observed with increasing ionic concentration. The trend shows:

- A sharp decline between 0.01 M and 0.05 M
- A plateau region beyond 0.05 M (~4–5 s)
- Increased variability at intermediate concentrations (0.03–0.04 M)

This behavior suggests a non-linear dependence of time on ionic concentration, with possible saturation or limiting effects at higher concentrations.

Supplementary Table 1

Technique	LOD	Sensitivity	Response Time	Complexity	Sources of Error	Citation
Potentiometric ISE (Na^+, K^+)	~1 mM	59.7 ± 0.8 mV/decade (Na^+); 57.8 ± 0.9 mV/decade (K^+)	<10 s	High - requires reference electrode, ion-selective membrane, signal conditioning electronics, and wireless transmission module	Electrode drift, biofouling of membrane, reference electrode instability, sweat pH interference, skin motion artefacts	[8]
Colorimetric microfluidic (Cl^-)	8.3 mM	Calibration curve-dependent	Minutes	Moderate - requires microfluidic fabrication, colorimetric reagents, and smartphone image analysis software	Ambient lighting variation affecting RGB readout, reagent degradation over time, non-uniform sweat filling of microchannels,	[9]

					image processing error	
Bubble rupture sensor (this work)	0.01M	376.7 s mol^{-1} L at 0.01 mol L^{-1}; 7.6 s mol^{-1} L at 0.15 mol L^{-1}	~60 s	Minimal -requires only SDS-glycerol bubble solution, no electrodes, no reagents, no electronic transduction	Ambient humidity and temperature variation, inconsistent bubble volume, non-uniform analyte deposition, stochastic nature of thin film rupture	This work