STATISTICAL EVALUATION OF THE PERFORMANCE STABILITY OF A SWEAT BIOLOGICAL SENSOR

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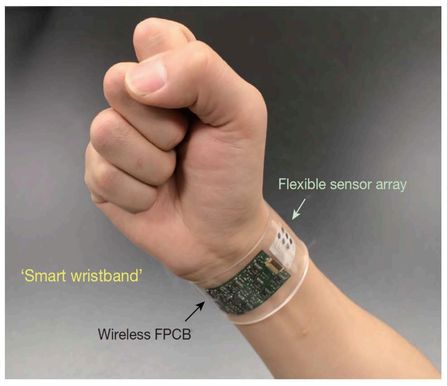
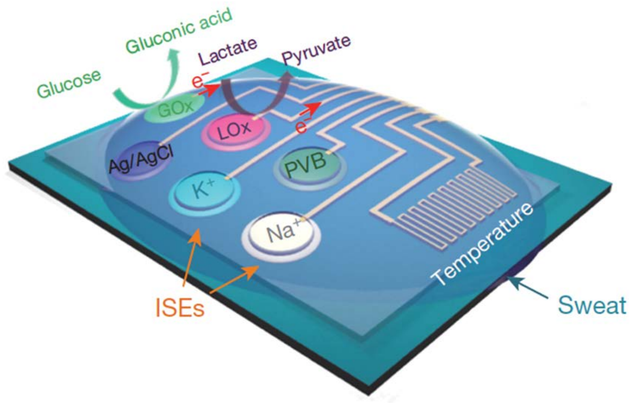
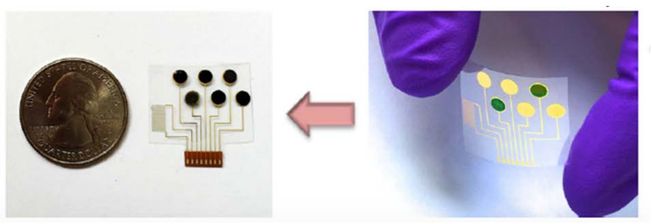
ABSTRACT

Human sweat contains much information about the physiological condition of a person. Biological sensors monitor concentrations of important sweat components such as potassium, sodium, glucose, lactate. Sensors are placed in direct contact with human skin. This approach allows for direct and continuous monitoring of the physiological parameters which is paramount for real-time health monitoring. Data obtained with sweat sensors is rich. The reliability of such data depends directly on the sensor's performance stability. This study is focused on the statistical evaluation of the performance stability of a glucose sensor.

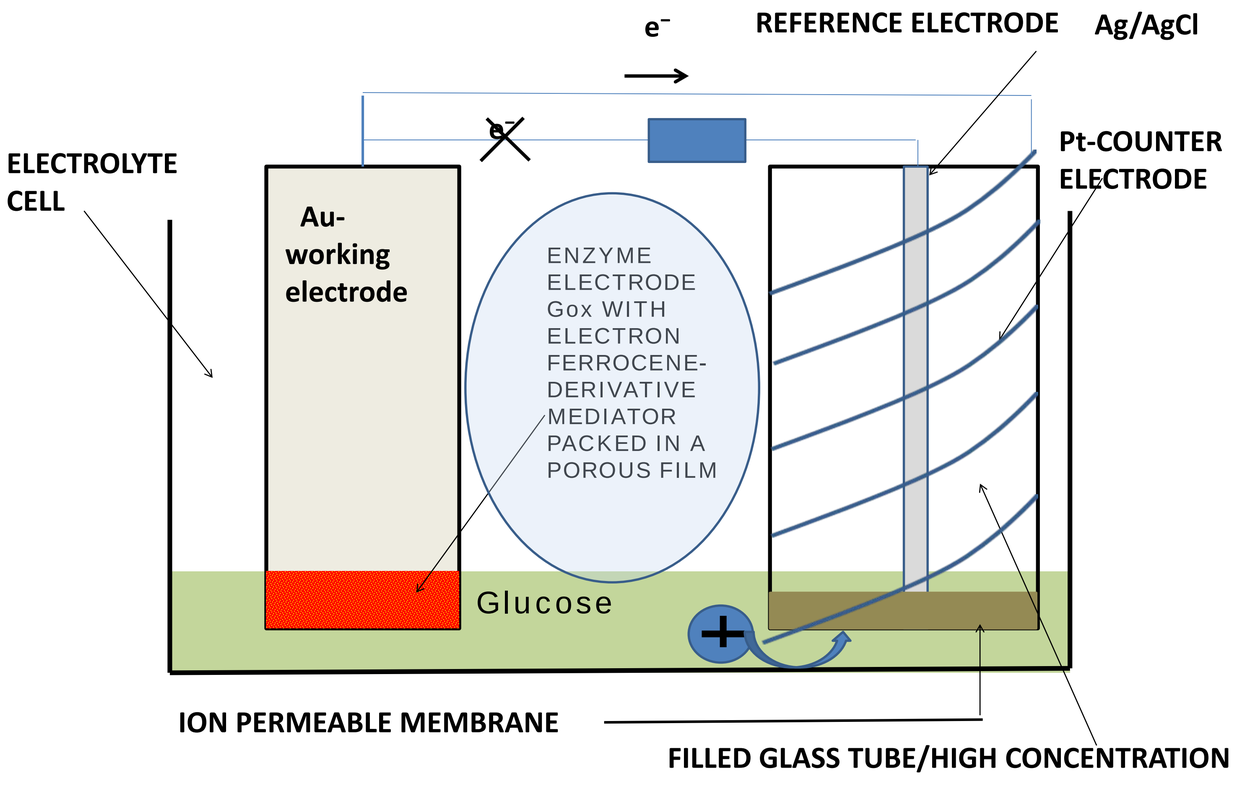
Biological sensors are non-invasive, are placed in direct contact with human skin, and are based on cutting-edge solid-state and flexible-electronics technologies.



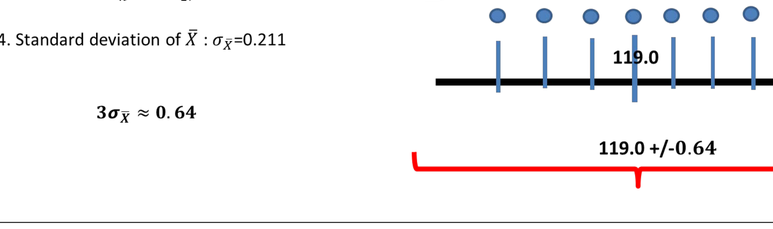




SCHEMATIC OF A GLUCOSE BIO-SENSOR



THE RESPONSE OF A TYPICAL GLUCOSE SENSOR



CALCULATION OF THE 3-STANDARD DEVIATIONS OF THE OUTPUT CURRENT OF THE SENSOR

1.Mean of the population (N=30) of the values of the el. current in nA
$\frac{3570}{30}$=119.0 (nA)

2. Values of the means of the samples $\bar{X}$ (nA): (size of the sample is n=27)

119.3, 118.9, 119.6, 119.0, 118.9, 118.7, 119.0, 119.3, 118.8, 118.9, 119.0, 119.1, 119.0, 119.4, 118.8, 118.7, 119.0, 119.1, 119.2, 119.1, 119.1, 119.2, 119.0, 119.1, 119.2, 118.9, 118.8

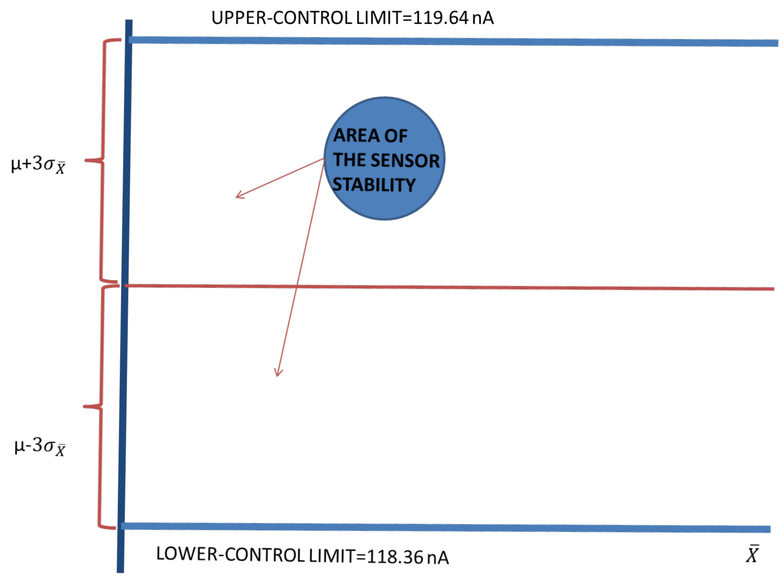
(Data from: Wei Gao, wgao@eecs.berkeley.edu)

3. $Mean\ \mu_{\bar{X}} = \frac{\sum_{i=1}^{i=27} \bar{X}_i}{n} = \frac{3213.0}{27}$=119.0

4. Standard deviation of $\bar{X}$: $\sigma_{\bar{X}}$=0.211

$3\sigma_{\bar{X}} \approx 0.64$

DOT-PLOT.
$\bar{X}$- distribution



Reactions at the Work Electrode

- GLUCOSE + GOx (ox) ⟹ GLUCONIC ACID + Gox (red)
- Gox(red)+2M(ox) ⟹ Gox(ox)+2M(red)+2H⁺
- At the electrode: 2M(red) ⟹ 2M(ox) + 2e⁻

(Gox-glucose oxidase –base of enzyme electrodes, PB-Prussian-Blue, M-mediator)

Reactions at the Reference Electrode

Ag/AgCl is a redox electrode. The corresponding equations are

$$\mathbf{Ag^+ + e^- \rightleftharpoons Ag}$$

$$\mathbf{Ag \rightleftharpoons Ag^+ + Cl^-}$$

It is a high-efficiency electrode, hence stable potential.
The reaction is governed by the Nernst equation;

$$\mathbf{E = E^0 - \frac{RT}{F} \ln a_{Cl}}\text{ , where } \mathbf{E^0} = 0.230\ v \pm 10\ mv$$

$a_{Cl-Cl\ concentration}$

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