

SESSION 1: PERFORMANCE OF A BIOSENSOR AND ANALYSIS OF THE CALIBRATION CURVE

An array of sensors has sensing sites with $50 \times 50 \mu\text{m}^2$ dimensions. The density of probe molecules is 10^{13} molecules/ cm^2 . A transducer measuring the mass of bound molecules is placed under each sensing site.

The calibration curve of each “sensing site + transducer”, (“measurand” is defined as the density of analyte molecules captured on the surface), is linear and passes by the following points:

$(3 \times 10^{11} \text{ molecules}/\text{cm}^2, 20 \text{ AU})$, AU: arbitrary units

$(6 \times 10^{11} \text{ molecules}/\text{cm}^2, 30 \text{ AU})$.

The transducer has an output of 10 AU when the concentration of the analyte is zero. Experiments have a standard deviation of 1 AU.

Exercise 1.

Large sensing sites:

- 1.a Calculate the sensitivity of a single sensor of the array.
- 1.b Calculate the resolution in the vicinity of the concentration value $C=3 \times 10^{11}$ molecules/ cm^2 (density of analyte detected).
- 1.c Determine the limit of detection (LLD or LoD) using the rule of “3 times the standard deviation”.
- 1.d Determine the lower limit of quantification (LLOQ) using the rule of “5 times the standard deviation”.

Exercise 2.

Small sensing sites:

In a new array configuration, the size of the sensing site is reduced down to $5 \mu\text{m} \times 5 \mu\text{m}$. However, the mass signal from each sensing site is read out by the same transducer used in the previous configuration with larger sites (the amplitude of the output per unit mass is the same as before). Assume the same offset and standard deviation as for exercise 1.

- 2.a Try to sketch the corresponding calibration curve (for one single sensor+transducer) in the range $[10^{11} \text{ molecules}/\text{cm}^2 - 10^{12} \text{ molecules}/\text{cm}^2]$.
- 2.b Calculate sensitivity of a single sensor of the array.
- 2.c Calculate the resolution in the vicinity of the concentration value 3×10^{11} molecules/ cm^2 (density of analyte detected).
- 2.d Determine the limit of detection and the lower limit of quantification
- 2.e Discuss the values of sensitivity, resolution LoD and LLOQ of the small sensor compared to the large sensors.