EE515 2024-2025

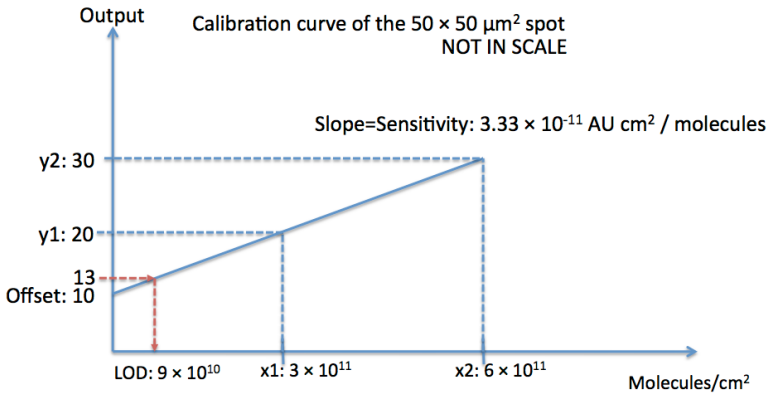
Fundamentals of Biosensors and Electronic Biochips

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

Exercise 1.

Large sensing sites:

From the data the calibration curve of each "sensing site + transducer" results:



1.a The sensitivity is equal to the calibration curve slope.

Sensitivity S = $\frac{\Delta y}{\Delta x} = \frac{10}{3\times10^{11}} = 3.33 \times 10^{-11}$ (AU · cm²)/molecules

1.b Resolution R = $2 * \frac{st\_dev}{S} = 6 \times 10^{10}$ molecules/cm²

1.c Limit of Detection LoD = (3× "standard deviation")/S $= 9 \times 10^{10}$ molecules/cm²

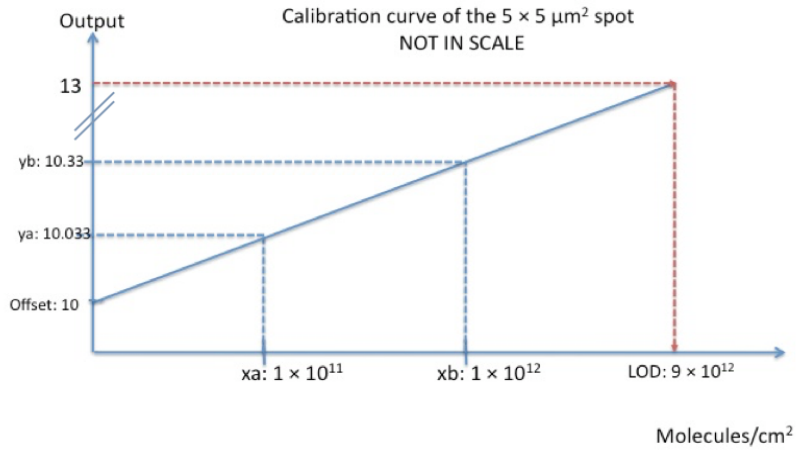
1.d Limit of Quantification LLoQ = (5× "standard deviation")/S =

$= 1.5 \times 10^{11}$ molecules/cm²

Exercise 2.

Small sensing sites:

2.a As we decrease both dimensions of the sensor by a factor 10, we decrease the total area by a factor 100, which means that we will capture 100 times less molecules, then the sensitivity is divided by 100, so the slope of the new curve is 100 times smaller.



2.b Sensitivity S = 3.33 x 10^{-13} (AU · cm^2)/molecules

2.c Resolution R =$2 * \frac{st\_dev}{S} = 6 \times 10^{12}$ molecules/cm^2

2.d Limit of Detection LoD: Offset + 3 x st_dev corresponds in this calibration curve to 9 x 10^{12} molecules/cm^2

Limit of quantification LLoQ: Offset + 5 x st_dev corresponds in this calibration curve to 1.5 x 10^{13} molecules/cm^2

2.e The sensitivity decreases by a factor 100 (same factor of the surface). The resolution and the limit of detection (expressed in density of molecules/cm^2) increase 100 times, which translates into an analytical range starting from 100 times higher concentration levels.