2013 Nanohub-U Course on
"Principles of Electronic Nanobiosensors"

nanoHUB BioSensor Lab (v2.0) Homeworks

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The following exercises are based on a web-enabled software called BiosensorLab (v2.0).

- If you do not have nanoHUB id, then goto **www.nanoHUB.org** to create a free account.
- Log on using your nanoHUB id.
- Launch the online tool BiosensorLab (https://nanohub.org/tools/senstran/) and select version II

Part I: Settling-Time

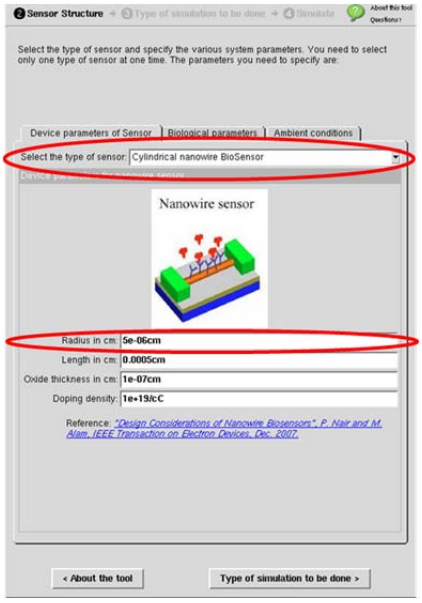
Problem 1.1: Minimum Detection Density of a NW sensor

Assume that you want to design a cylindrical nanowire (NW) biosensor of 50 nm radius for the purpose of capturing 20-bp (base pair) DNA molecules. The device is stable up to 10000 seconds (about 3 hours) in a fluidic environment, therefore measurement beyond that time limit is not acceptable. The surface conjugating parameters are not known exactly, but let us assume typical values of $k_F = 3\times10^6$ /(M×s) and k_R= 1/s.(All analyte concentration units are in Molar and surface concentration unit is in #/cm^2) The test fluid of 6 cc is injected to the sensor via a pipette (rather than continuous external flow).

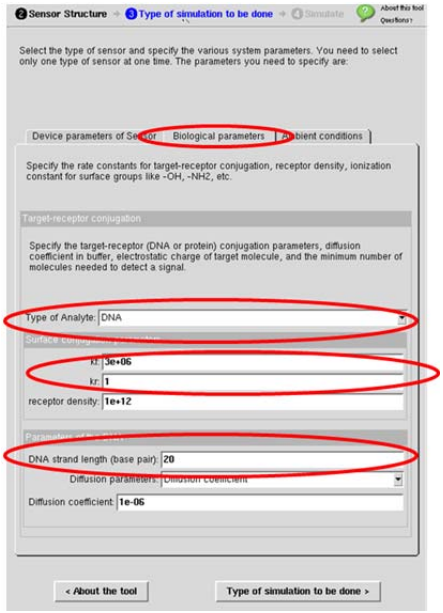
Find the minimum detection density given that the device's stability time is 3 hours.

Setting up the Simulator

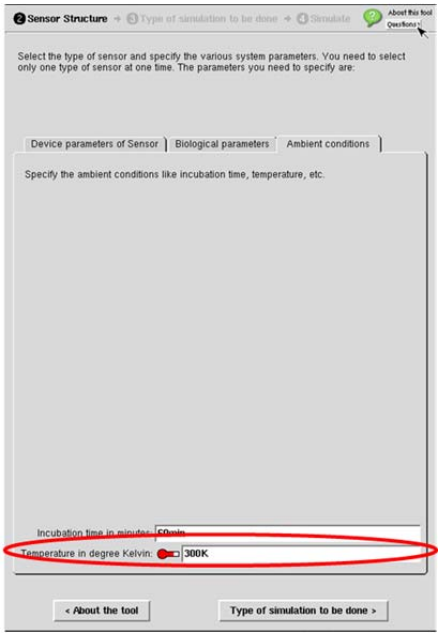
- In the "Device parameter of Sensor" tab, select the option "Cylindrical nanowire Biosensor" and set the nanowire radius of 50 nm (5×10^{-6}cm). Keep length, oxide thickness, and doping density the same as default values. Note these values so that you can refer to them later.



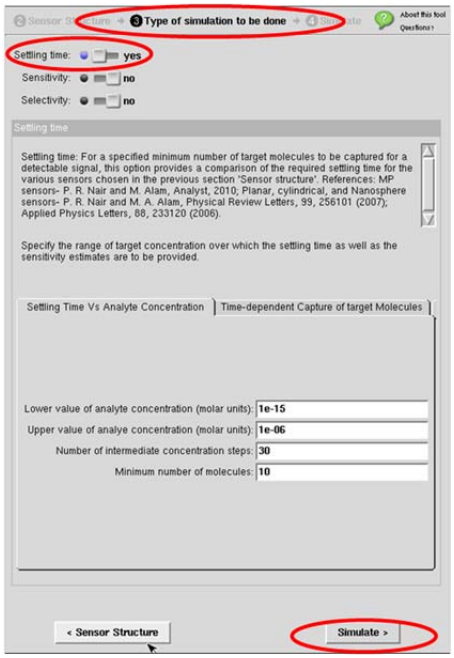
- In the "Biological parameters" tab, set "Analyte Type" to be DNA. Set $k_F = 3\times10^6$ /(M×s) and k_R = 1/s as indicated in the problem. In "Parameter of DNA" section, set DNA strand length (bp) to be 20.



- The measurements are done at room temperature, so set the Temperature in degree Kelvin to be 300 K in the "Ambient Condition" tab.



- Move on to the "Type of simulation" phase. In this problem, we are interested in the settling time. So turn on the "settling time" switch. We will keep all the parameters in this option unchanged for the time being.



- Click the **Simulate** button.

Examine the plots to find the minimum detection limit of the biosensor.