Modeling and simulation of advanced carbon nanotube sensors

Master / Semester / Bachelor Thesis

Motivation

Sensors based on carbon nanotubes have a disruptive potential for portable or non-invasive devices because of their small size and tiny energy dissipation. One example —out of many—is the pressure sensor shown in Fig. 1., the smallest worldwide.

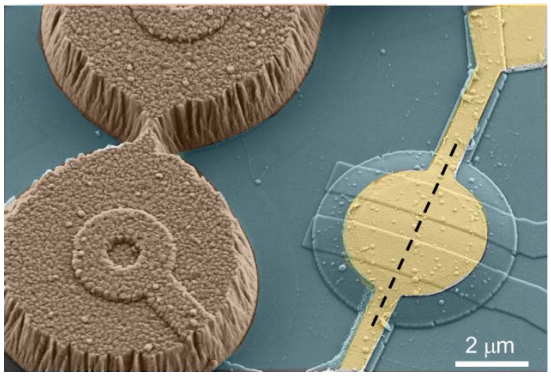

Fig. 1. Image of a miniaturized pressure sensor utilizing one single walled carbon nanotube (SWNT) as the displacement transducer

Despite the impressive performance shown so far, the operation of these sensors is not fully understood yet. This situation hinders the design of devices with optimal performance.

Your Task

In this project, your task would be to develop modeling and simulation tool(s) to aid in the design of advanced carbon nanotube based sensors. Measurements of a device are shown in Fig. 2 where the current (I_d) is shown to be dependent on the pressure applied to the sensor—in this case, pressure deflects the sensor diaphragm that is changing the gate capacitance. More specifically, your goal would be to compute the current through a carbon nanotube channel that is embedded in a microstructure. To achieve that, you will be utilizing a combination of tools such as Comsol (for electrostatic and mechanical modeling) and own Matlab code (for quantum transport).

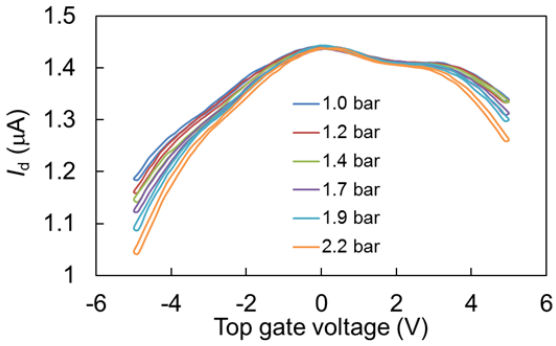

Fig. 2. Measurement of the change of the transfer characteristic (I_d vs V_g) upon modifications in the applied pressure.

Your exact tasks will be defined as a function of your available time and background. The toolchain will be useful to us not only for the design of pressure sensors, but for other devices as well, e.g. mechanical resonators, gas sensors, etc.

Your profile

You are an engineer or physicist and you are interested in learning how to model complex systems like sensors whose behavior is multi-physics. You wish to gain hands on experience with multi-physics FEM tools such as Comsol or learn Matlab programming. You want to learn—and you're not scared of—some basic quantum transport. You care about working in a scientific, systematic fashion and you wish to learn how to write a sound scientific report.

Contact

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