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Master Thesis:

Design of a Portable Sensor Front-End for Carbon Nanotube Air Pollution Sensors

Motivation: Recent advances in the development of carbon nanotube (CNT) based gas sensors [1] generated great interest in their application for environmental sensing. CNT gas sensors exhibit a high sensitivity to certain pollutant molecules while consuming power in the μW range, which is orders of magnitude less compared to state-of-the-art gas sensors, *e.g.* metaloxide based sensors. These properties envision the integration of CNT sensors in devices where energy is limited, *e.g.* battery-powered wearables.

In this thesis we want to take a next step towards an integration of CNTs into wearables by investigating various requirements. The thesis can be roughly divided into two parts:

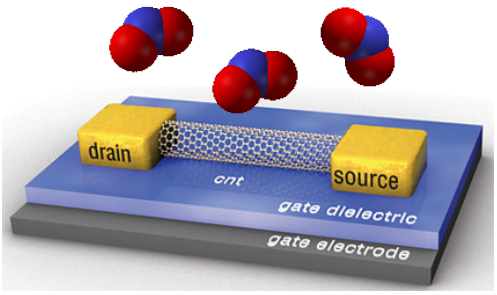

Figure 1: Basic CNT sensor model

1.) Sensor front-end. CNT based gas sensors are field-effect transistors, see Fig. 1, where the current between source and drain is affected by the presence of gas molecules in ambient air when a gate voltage is applied. These currents are usually very low ($< 1\mu A$) and thus require low-current meters for accurate sensor measurements. Further, the CNTs behaviour can be influenced by various techniques, for instance gate voltage pulsing. One task of this thesis is to design a PCB featuring a sensor front-end that *(i)* is able to measure low currents with high resolution ($< 10nA$) and *(ii)* takes care of different sensor control settings.

2.) CNT sensor characterization. We will place several sensors next to a high-quality air monitoring station where we have access to a variety of highly accurate pollutant measurements. With the help of these reference signals we want to characterize the CNT sensors with respect to sensitivity, noise, required ADC resolution etc. in a real environment. This will greatly help to come up with an optimal strategy for a succesful integration of CNT sensors into wearables.

Requirements: Solid electronics skills. Experience with Altium Designer (or any similar tool) is advantageous but not required.

Note: This thesis will be in coorperation with the Micro- and Nanosystems group at D-MAVT. For more information have a look at: http://www.micro.mavt.ethz.ch/

Interested? Please have a look at http://www.tec.ethz.ch/research.html and contact us for more details!

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References

[1] K. Chikkadi, M. Muoth, C. Roman, M. Haluska and C. Hierold, *Advances in NO2 sensing with individual single-walled carbon nanotube transistors*, Beilstein J. Nanotechnol., vol. 5, pp. 21792191, 2014.