Fabrication and Characterization of Silicon Nanowire Sensors

**MOTIVATION**

Nanowire field effect transistor (FET) arrays are developed as a platform for an ion and (bio)-chemical sensor that enables an electrical and label-free detection of charged particles. The sensing mechanism is based on the shift of the transfer curves, due to the adsorption of the target ions or molecules. To enable the specific detection of (bio-) analytes, the surface of the nanowire has to be functionalised with appropriate receptors.

**SENSING PRINCIPLE**

\[
\text{MOH} \Leftrightarrow \text{MO}^- + \text{H}^+ \quad \text{(deprotonation)} \\
\text{MOH}^+ \Leftrightarrow \text{MO} + \text{H}^+ \quad \text{(protonation)}
\]

Sensor signal: shift of the transfer curves (\(\Delta V_g\)), due to surface charges.

**SENSOR FABRICATION**

- 48 nanowires (SiNWs) per sample
- nanowire width: 100nm – 1µm
- nanowire length: 6µm

**LOW FREQUENCY NOISE**

- dominant noise source: trap states in the gate oxide
- contact regime: higher noise generated by the contacts
- accuracy increases with the SiNW width: 0.019% of 60mVpH-shift
- nanostructures enable smaller detection limits

**SUMMARY**

- successful fabrication of silicon nanowire sensors:
  - nanowire widths: 100nm to 1µm
- ideal pH-sensitivity:
  - Al₂O₃ and HfO₂ as detection surface
  - sensitivity is independent of nanowire width or gate oxide (Al₂O₃ and HfO₂)
  - feasible to use nanowire FET arrays for multiplexed detection
- low frequency noise in SiNW sensors
  - better accuracy for larger SiNWs
  - small SiNWs have better detection limits

**OUTLOOK**

- changes in the sensor design for multiplexed detection
- multiplexed detection of ions and bio-molecules in differential measurements

**REPRODUCIBILITY**

- very high reproducibility of electrical properties
- important for differential measurements