Silicon-Nanowire Field Effect Transistors as Bio-Sensors

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Thesis: sensing with modulation of Schottky barriers?

- Single nanowire FET with intruded Ni contacts
  - annealing leads to axial diffusion of Ni into the nanowires
  - metallic NiSi2 is formed with a sharp interface to the intrinsic silicon of the wire

- Atomic sharp metal-semiconductor interface poses defined Schottky barriers (SB-FET)
- Effective manipulation of barrier height with applied electric fields (gate voltage) is possible
- Binding events of target and probe molecules near Schottky barriers locally bend bands and lower energy barriers for electrons or holes

Electrical characteristics of single nanowire FETs

- Back gated single nanowire FET
  - 20nm thermal silicon oxide gate dielectric, source-drain (SD) voltage 0.5V
  - (CH2)3NH2 (alkane chain) terminated wires show ambipolar behaviour
  - Untreated wires behave like p-doped wires (unipolar behaviour)
  - Totally different IV characteristics, not just a simple shift like it is expected for a change in surface charge

- Suggested mechanism
  - Surface Fermi level pinning or “doping” (charge transfer) due to polar molecules like H2O
  - “p-doped” nanowires: lower barrier for holes, higher barrier for electrons lead to rectified charge transport
  - Alkane chains shield from polar molecules and possible charge transfer

Nanowire growth via VLS (vapor liquid solid)

- Bottom up synthesis of silicon nanowires in CVD furnace via VLS method with silane as precursor
- Gold particles with a diameter of 20nm made by Turkevich method serve as catalyst
- Growth time of 10min at 450°C with a dilute silane gas (SiH4:H2 = 1/10) flow of 200sccm (60Torr) leads to 7-10µm long monocrystalline silicon nanowires

- Creation of parallel arrays of nanowire FETs
  - Increase of sensitive area and signal amplitude compared to single nanowire FETs

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