AMBIPOLAR SiNW FETs FOR LOW CURRENT AND TEMPERATURE SENSING

Davide Sacchetto, Giovanni De Micheli, Yusuf Leblebici
Ecole Polytechnique Federale de Lausanne, 1015 Switzerland davide.sacchetto@epfl.ch

Future technological innovations will most likely be concentrated on novel materials, structures, or state variables, leading to significant modification of the transistor design. Novel Materials: high-k, SiGe, III-V, CNTs, graphene Novel Structures: SOI: partial or full channel depletion, multi-gate: double, FinFET, GAA/FET, gate-all-around FET Novel State-Variables: spin, ambipolarity

In this work we extend the application of Si nanowires to current and temperature sensing. A range of sputtered SiO₂ passivation layer, to avoid any metal contamination.

Novel Structures:
- GAA polysilicon gates: having 4μm channel length.
- SOI: 100nm SOI wafers.
- Sacrificial oxide growth: 500nm wet oxidation.
- Gate oxide: 20nm dry oxidation in O₂ atmosphere at 1050°C.
- Gate stack: 500nm polysilicon deposition.
- Contact opening: 500nm low temperature oxide deposition.
- Electrical contact formation: 55nm Ni + 20nm Ti deposition.
- Lift-off patterning.
- NSI formation at T=400°C.

Fabricated Structure:
- a) A 20μm long SiNW with 2 parallel GAA polysilicon gates having 4μm gate lengths.
- b) A FIB cut cross-section image showing the SiNW channel surrounded by a 500nm polysilicon top gate.

Current Transduction
- Measured input-output transfer characteristics of a hysteretic inverter based on a single Si nanowire FET with low current bias, showing current-dependent thresholds.

Temperature Transduction
- The hysteresis window shrinks with increasing temperature. Within this T range, the temperature sensitivity of 10 mV/°C is related with the thermionic current regime.

Conclusions
- The Schottky barrier Si nanowire FET has been demonstrated suitable for precise current and temperature sensing. Sensitivities ranging in between 17mV/μA and 40 mV/μA for current and between in 10 mV/°C and 40 mV/°C for temperature sensing associated with the different current conductance mechanisms are reported. The compatibility of Si nanowires for both sensing and logic applications makes these structures suitable for heterogeneous integration within the same fabrication platform scheme.

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References