A two-channel device in SOI-technology

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In the past, conduction channels of conventional MOSFETs, which at this time were following Moore's law, were improved by better conduction in new material systems as strained silicon and SiGe. Later, better gate control over the conduction channel was achieved in new architectures as FDSOI or FinFET. In nowadays state of the art transistors with channel lengths around ten nanometers, quantum transport becomes essential. We thus extend our previous semi-empirical model for quantum transport in a conventional nano-MOSFET [1] to a generic model applicable to both, SOI-transistors and double-gate FinFETs. In this contribution we focus on FDSOI. Based on SOI-technology we propose a two-channel transistor operating on quantum mechanical resonant tunneling between two conduction channels in the Si-layer of the SOI-substrate (see Fig. 1 and Ref. [2]): In the ON-state the two channels are resonant and conduction between them occurs while in the OFF-state the two channels are non-resonant and electrically decoupled due to absence of tunneling. Since the transition between ON- and OFF-state can be tuned with very small gate voltages in the range of 10mV and less, it is possible to operate the two-channel transistor with small supply voltages and therefore with small heating. First experimental data are taken into account in our presentation.

[1] U. Wulf, H. Richter, J. Kučera, M. Wiatr, J. Höntschel, and M. Horstmann, Mathematics 5,68 (2017)
[2] Pat. DE 10 2018 104 305 A1 2019.07.04

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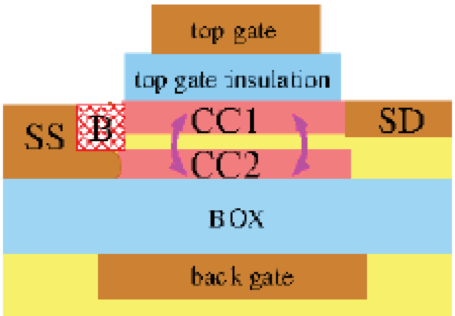

Figure 1: The two-channel transistor is a standard SOI-transistor with the additional elements SS = shallow source, B = blockade, CC1 = conduction channel 1, CC2 = conduction channel 2, and SD = shallow drain. The arrows in magenta represent resonant tunneling controlled by the voltages at the top- and at the back-gate.