Simulation study on ONO gate stacked biosensor-CMOS hybrid system

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Sensing devices which detect small biomolecules such as DNA and virus have been widely researched since the advancement of nano-fabrication technology [1]. Silicon nanowire (SiNW) FET-based biosensor has been considered as a one of the promising devices due to its high sensitivity, low cost, and the capability of real-time/label free detection. Moreover, the SiNW biosensors can be co-integrated with CMOS read-out circuits by using top-down fabrication process. Various read-out circuits have been demonstrated for the purpose of signal processing, data storing [2] and achieving high sensitivity or signal to noise ratio (SNR) [3, 4]

In this study, the hybrid system composed of CMOS read-out circuit with oxide-nitride-oxide (ONO) gate stack and FET-based sensor is proposed. Threshold voltage (V_T) mismatch originating from the variation of channel doping can be effectively adjusted in the system by injecting electrons (program) or holes (erase) into the nitride via Fowler-Nordheim tunneling throughout the bottom oxide.

The proposed hybrid system was simulated to verify the effects of the V_T modulation. Common source amplifier configuration which was proposed as a voltage-readout pH sensor [3] was used for mixed mode device simulations. The simulation results reveal that the adjusted V_T of the MOSFET enhances the sensitivity because the output voltage of the FET-based sensor cannot be changed according to pH variation if the V_T is too low or high to match the resistance of the MOSFET with that of the sensor.

References

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