Sharp Switching SOI Devices

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MOSFET scaling requires maintaining a high drive current for speed as well as a low OFF current for power saving. The reduction of the supply voltage is impeded by the subthreshold slope which cannot be lowered below 60 mV/decade, even in fully depleted MOSFETs. This explains the growing interest in CMOS-compatible devices that switch more abruptly than MOSFETs.

Two classes of devices will be presented and discussed. Tunneling FETs are reversed-biased PIN gated diodes: gate voltage controls the electric field in the interband tunneling junction P^+/N^+. The TFET can in principle be turned on/off faster than the subthreshold current of a MOSFET. The operation mechanisms will be described based on available experimental data and models. We will review innovative concepts and technological solutions for improving ON current and subthreshold switch.

Recently proposed positive feedback transistors have similar gated-diode configuration, but are operated in forward-bias mode. Electrostatic barriers are formed, via gate disposition, to prevent electron/hole injection into the channel until the gate bias reaches a turn-on value. Due to the bandgap modulation along the channel, the device switches abruptly (< 1 mV/decade) to a high current value. We will discuss the device physics, architecture, and outstanding performance of a pragmatic variant named Z^2-FET. There are exciting applications in CMOS-compatible memories, logic and protection circuits with new schemes of operation.