Band-modulation devices for memory and sharp switching

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The band-modulation and sharp-switching mechanisms of the Z^2-FET device are attractive for capacitorless 1T-DRAM memory and logic switch applications. The Z^2-FET is a forward-biased PIN diode with large gate underlap. Gate-controlled electrostatic barriers are formed in N^+PNP^+ structure to block electron/hole injection into the channel. When the gate or drain bias reaches a turn-on voltage, a positive feedback mechanism causes the device to switch abruptly from the OFF state to the ON state.

We present several recent variants of the Z^2-FET fabricated in advanced FD-SOI technology. The output *I–V* characteristics show a large hysteresis that can be used for static memory operation. In transient mode of operation, the characteristics are modified because the device is in a non-equilibrium state. The Z^2-FET memory features a high current margin, low power consumption, and fast access time.

A second application of the Z^2-FET is as a logic switch, which is achieved by inhibiting the hysteresis effect. Fast pulses on the gate enable hysteresis-free switching. We discuss the key parameters and biasing conditions that impact the device performance. Z^2-FET switches show extremely low OFF-state leakage and abrupt switching behavior, so they can be operated at lower voltage with higher energy efficiency than standard CMOS transistors.