Nanoelectronic Technology: In Search of the Ultimate Device Structure

S. M. Sze
National Chiao Tung University, Taiwan, ROC

Since early 1970's, the MOSFET has become the dominant device for microelectronic industry. In the past 30 years, the MOSFET dimensions have been scaled down from 5 μm to 0.09 μm (90 nm). However, the device configuration remains essentially a single-gate bulk-silicon planar structure.

As we move into the nanoscale regime, the planar structure will soon reach its physical limit. Many new MOSFET structures have been investigated, including the 6-nm ultra-thin-body silicon-on-insulator MOSFET, and the 10-nm non-planar double-gate finFET. We will evaluate these devices and their ultimate performances based on six criteria:

- low manufacturing cost,
- low power operation,
- high current drive capability,
- high level of integration ($>10^{10}$ devices/chip),
- high reproducibility (better than $\pm 5\%$), and
- high reliability (operating time >10 years).

Over the years, many alternative technologies have been proposed, such as organic devices, molecular devices, quantum devices, carbon nanotubes, *etc*. Any alternative technology must be evaluated based on the same criteria. In addition, it must be compelling and further MOSFET scaling must become difficult and not cost-effective. Until these two happen together, it is unlikely that any alternative technology will replace MOSFET with its enormous infrastructure built around silicon.