Nanoscale Fast Switching Transistors

GMU-23-025

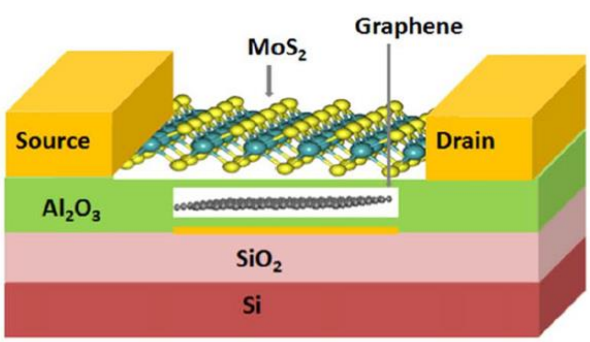
Nanoscale Fast Switching MOSFET with 2D Ferroelectric Heterostructures

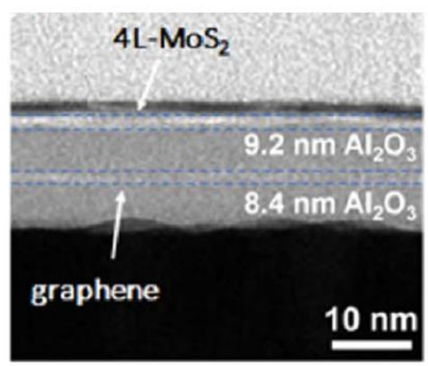
This is a new class of MOSFET transistor that shrinks the transistor's size to the nanoscale range without compromising functional performance parameters (e.g., switching speed, subthreshold-slope characteristics, leakage-current, low supply voltage, etc.) This technology defines the state of the art in transistor technology. Applications include microprocessors, computer memories, and many other information technology devices. Since ubiquitous electronic equipment such as smart phones, personal computers, and information technology equipment employ billions of transistors, the market size for this technology is very large.

Progress in information technology is based primarily on the ability to increase the density of transistors on a semiconductor chip by scaling down MOSFET transistor dimensions to only a few nanometers. However, to date the shrinking of transistor size to the nanoscale range decreases important performance parameters. For example, the required low supply voltage and the short channel effects associated with smaller size limit the switching speed and the subthreshold slope of the current-voltage characteristics. The current invention solves these difficulties using new electronic transport and tuning gate capacitance mechanisms.

These transistors employ novel 2D ferroelectric heterostructures with a thickness of only a few atomic mono-layers to improve the quantum transport mechanisms between source and drain and to tune the gate capacitance. This configuration overcomes many difficulties associated with scaling down transistor size. The use of a heterostructure that includes ferroelectric layers in the transistor channel increases the quantum coupling of the channel-gate stack, ultimately producing the desired small subthreshold slope. These devices have much improved performance parameters in terms of switching speed and energy use. These transistors will be particularly suitable for military and high end applications.

Stage of Development: early prototype





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