SELF-HEATING EFFECT IN SILICON NANOWIRES FIELD-EFFECT TRANSISTORS

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Abstract

Since conventional silicon metal-oxide-semiconductor field-effect transistor (MOSFET) is approaching its scaling limit, novel devices structures are being explored lately. The scaling of the technology to dimensions below ~45 nm, where short channel effects start to become significant, has required significant changes to the simple planar two dimensional (2D) MOSFET. Nanowire Field-Effect Transistors are being investigated to solve short-channel effects (SCE) in future MOSFET technology. Silicon Nanowire Field-Effect Transistor (SiNWT) has attracted broad attention among them.

On one hand, reducing the transistor active area lowers the power requirements, since the voltage needed for the device operation is reduced accordingly to its size. On the other hand, loss of electrostatic control, mobility degradation, SCE, and the inability to further reduce the series resistance are some of the main drawbacks arising from the device shrinking. Furthermore, reducing the MOSFET area impacts the reliability and variability of such devices. More and more devices per unit area results in increasingly large amounts of heat generated per unit volume. Self-heating may lead to a substantial increase in the effective operating temperature of the device, which degrades the device electrical performance and affects device reliability. Related to this phenomenon, many studies show details of Joule heat generation in silicon, as well as the effects of self-heating on scaling options of ultra-thin transistors.

To understand the device physics in depth and to assess the performance of SiNWT, simulation is important. Computer-aided-design tools can reduce both the cost and the development time of these silicon nanotransistors. From the previous assessment, our study is based on simulation by using COMSOL multiphysics software.

The present project aims to localize the hot spot in the SiNWT, and to plot the distribution of the heat in the channel of the SiNWT, in order to better understand of self-heating on the device performance from an electrical standpoint is discussed. For this purpose, the simulation results will be compared with the reported results in the literature.

Figures used in the abstract

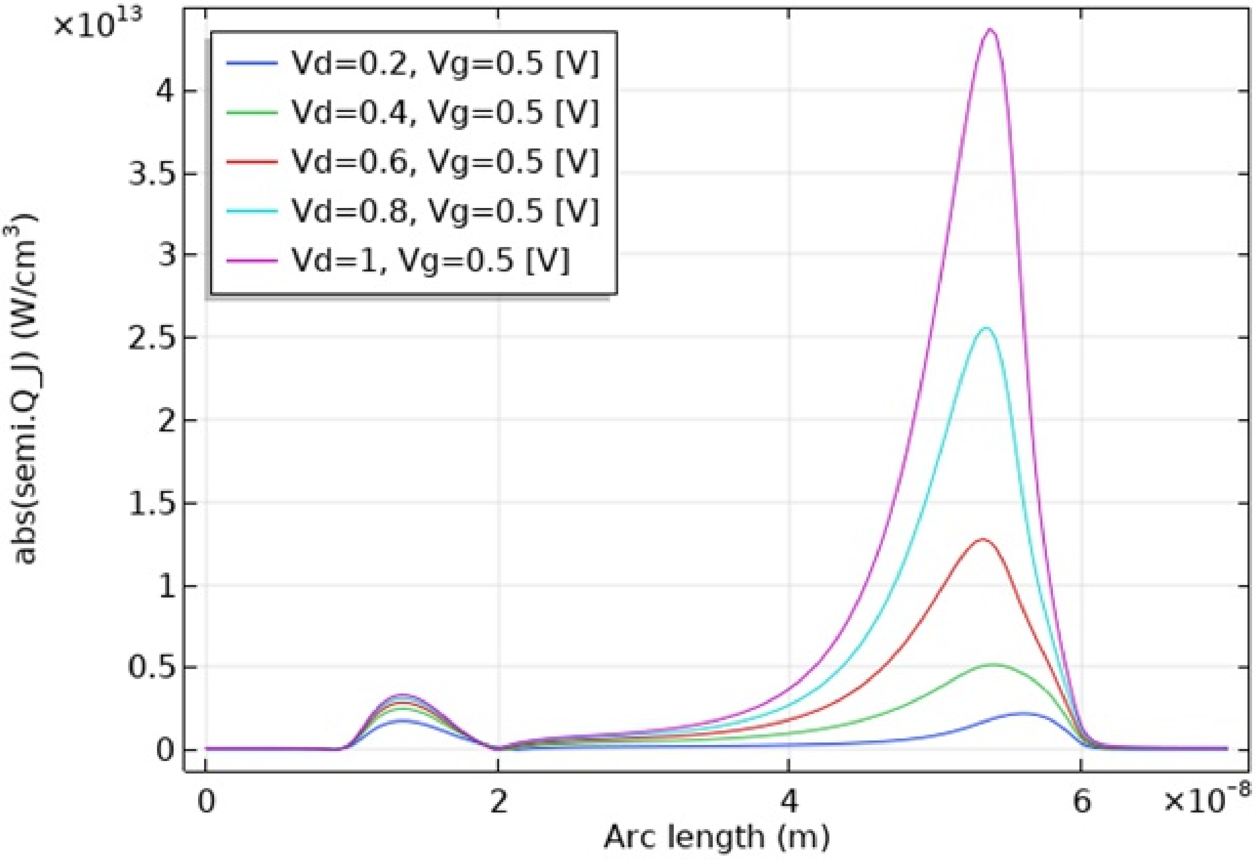

Figure 1 : Distribution of the heat in the SiNWT channel.