*Yang Fu*

# A Better Performance of Transistor

**In semiconductor industries, the processing technologies reach the nano-level scale - around one hundred thousandths of the diameter of human hair. The challenges to optimizing the electron transfer in the transistor are highlighted. Electrons transfer in a circuit as cars on the road. Scientists are trying to establish highway overpasses to make electron transferring as they wish, so that it would be available to obtain lower power consumption and high-efficiency circuits. The evidence shows InGaAs quantum-well transistor is a promising candidate.**

We have experienced a tremendous advancement in computational power in the last one hundred years. A critical step in the advancement was the development of an electronic component - the transistor. Commercialization of transistors began in 1958, when Jack Kilby at Texas Instruments built the first integrated circuit - all the circuit components were made directly on the same silicon substrate. It allowed electronic components to be smaller and easier. Nowadays, as the size of electronic products shrinking significantly, it brings much convenience to people's life, especially the application on mobile phones, which have already become the necessities of every person’s life.

However, as the processing technologies reach the nano-level scale, around one hundred thousandths of the diameter of human hair, the challenges to the stability of electronic circuit are highlighted. The failures include leakage issue due to a slight current variation in power supplier, signal error because of electromagnetic interference, and so on.

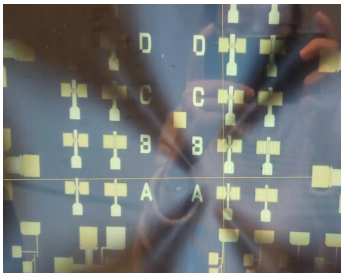
Some scientists have been trying to utilize the effect caused by nano processing, which is called the quantum effect. Let us assume electrons in a circuit run as cars on the road. The cars can run very fast on a flat road, but it would be horrible if all the cars drove extremely fast on a narrow road. Scientists are making an effort to control the cars passing through a narrow road orderly as they wish, which means some cars need to speed up and some need to slow down. The quantum effect is to be able to form highway overpasses or deceleration zones by adjusting the applied voltage in the circuit, so that it would be available to realize a power amplifier or high-frequency signal.

This thesis aims to explore the InGaAs quantum-well transistors. On the one hand, it can be applied to low noise at high gain and frequency due to minimizing the interference of other factors. On the other hand, InGaAs material is an attractive material with similar mechanical properties to Silicon, such as expansion rate and hardness. Finally, the sandwich structure quantum-well transistors are potential transistors to be a replacement for the widely used silicon components in nowadays electronic industry.

Supervisor: **Erik Lind & Rainer Timm**
Degree project 30 credits in 2022
Physics and Astronomy department, Lund University

*Yang Fu*

In summary, quantum-well transistors are designed to increase the logic speed and reduce the power requirements in semiconductor production. These also increase quantum-well transistors for design-automation tools that benefit from low power, small size, and high speed. The improvement will lead to the development of various areas, such as quantum computers, quantum communication and machine learning.




quantum-well transistors

Supervisor: **Erik Lind & Rainer Timm**
Degree project 30 credits in 2022
Physics and Astronomy department, Lund University