Progetto di Ricerca

Titolo del Progetto di Ricerca: "TCAD study of the potential performance for InGaAs and GaN nano-sheet FET/HEMTs"

Attività proposta

The proposed research will focus on the theoretical investigation of the main performance limitations of next-generation nanosheet transistors. The strict interaction with the Institute of Electronics, NYCU University, Taiwan, will allow us to receive measured data on a number of test devices jointly designed for the specific analyses under study. This project will particularly address InGaAs nano-sheet MOSFETs as a first goal, focusing on the performance of extremely scaled devices. In a second phase, GaN finFET/HEMTs and nano-sheet FET/HEMTs will be simulated, by focusing on the adoption of such alternative wide-bandgap materials for innovative integrated power applications.

Main objectives:

1) One of the goals is to determine whether the performance of InGaAs nano-sheet MOSFETs is better or worse compared to Si nano-sheet MOSFETs. Currently, the performance of Si-MOSFETs is extremely high, with not only excellent DC characteristics but also superior RF performance with fT and fmax both at 300 GHz compared to InGaAs MOSFETs. It is necessary to confirm whether the superior performance of Si MOSFETs is due to the characteristics of the intrinsic channel part of Si MOSFETs being superior to those of InGaAs MOSFETs, or whether it is due to the fact that InGaAs MOSFET fabrication technology is still immature. Examples of immature aspects include resistance of the source-drain, gate oxide film thickness, and insufficiently small channel length. Therefore, it is advisable to simulate assuming that InGaAs MOSFET fabrication technology is sufficiently developed and compare the performance of InGaAs MOSFETs by setting parameters such as channel length and gate oxide film thickness to values similar to those of Si MOSFETs in the literature.

2) To properly perform simulations of InGaAs nano-sheet MOSFETs, it is necessary to calibrate the parameters used in the simulation by comparing simulation results with experimental data. Which will be provided by the NCYU Institute of Electronics.

3) Optimization of InGaAs nano-sheet MOSFETs is necessary. For example, what thickness of the nano-sheet is optimal? What physical phenomena occur when the thickness is reduced to the limit? By thinning the film, how do factors such as local thickness variation, fixed charge on the surface, interface states on the surface, mechanical stress of the film, and temperature rise of the film affect the channel conduction of MOSFETs? TCAD simulations will be carried out to understand the role of technology on the final performance.

4) Simulations of GaN finFET/HEMTs, nanowire FET/HEMTs, nano-sheet FET/HEMTs will be developed at the University of Bologna as a first step, in order to find what kind of device structure is effective for power devices and how to optimize them.

This activity is a follow-up of the research tasks addressed in the European Project REACTION.