GTS Framework 2014.09

global TCAD solutions

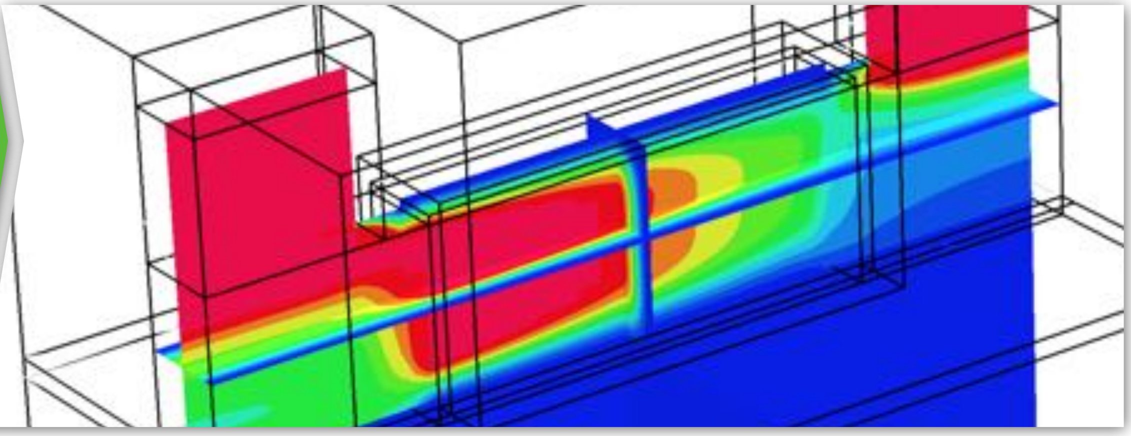
Predictive Simulation of InGaAs MISFET Devices

Physics of Carrier Transport in III/V-based Technology

GTS Framework Application:

Predictive III/V Materials Simulation

- ***Electrostatics***
- ***Confinement***
- ***Mobility***
- ***Dev.Charact.***
- ***DIBL***



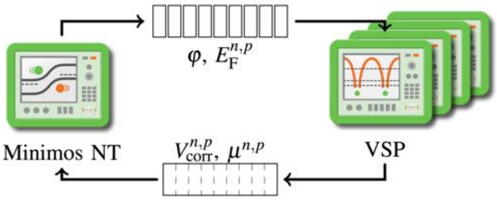
III/V materials are considered good candidates for replacing silicon as channel material due to their low effective mass. Non-planar technology provides superior electrostatic control. Profound design decisions need to be made, and efficiently finding the most advantageous and reliable path is key to successful device design.

Only physical modeling provides substantial, reliable data for predictive simulation, and features a prediction window unachievable by conventional empirical models. Based on latest scientific research, GTS provides a comprehensive and efficient solution.

Applications

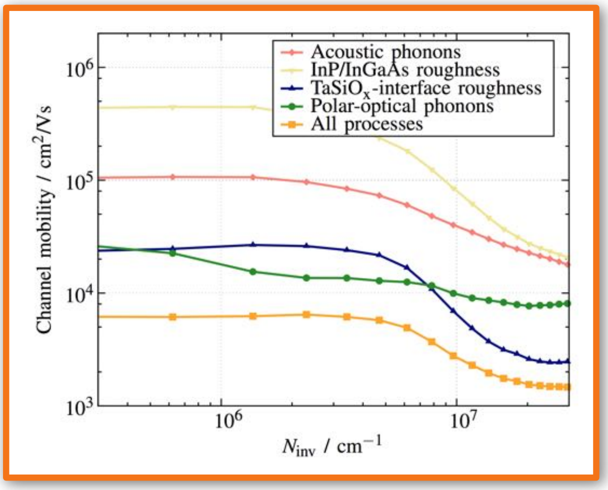
Physical simulation of devices, to predict:

- CV curves, conductance
- Device characteristics
- DIBL, subthreshold slope



Key Features

- Predictive, physical simulation
- Linearized Boltzmann transport
- Polar-optical phonon (POP) scattering
- Surface-roughness scattering (SRS)
- Non-parabolic, multi-valley electronic structure
- Dielectric model
- Optimizer, parameter fitting
- Interface for calibration of empirical models
- Computationally efficient, automatic job distribution in cluster



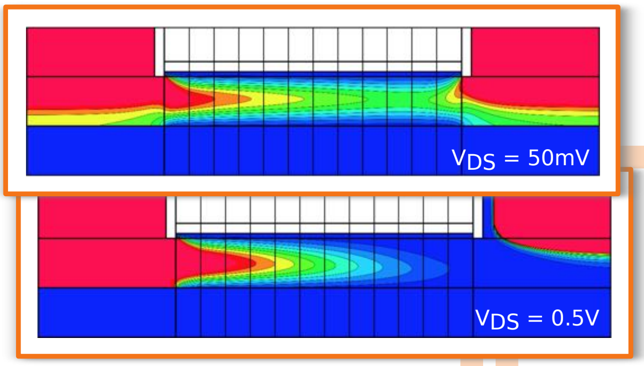
Electron mobility vs. inversion density in the fin of an InGaAs / InAlAs / InP FinFET. Clearly telling the dominat scattering effects in each area, the physical models provide substantial data for decisions in device design and optimization.

Developed in collaboration with the Vienna University of Technology, group T. Grasser and group H. Kosina

Tools: GTS Structure, VSP, Minimos-NT, GTS Vision.

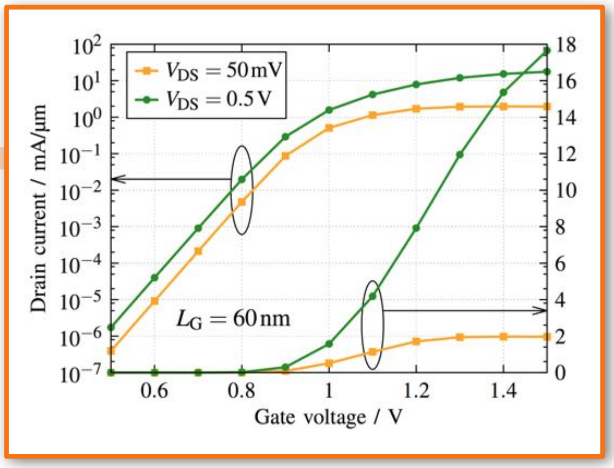
Predictive Simulation of 60nm InGaAs Quantum-Well MISFETs

Device Level: Macroscopic Transport (Minimos-NT)



Electron concentration in linear / saturated regime

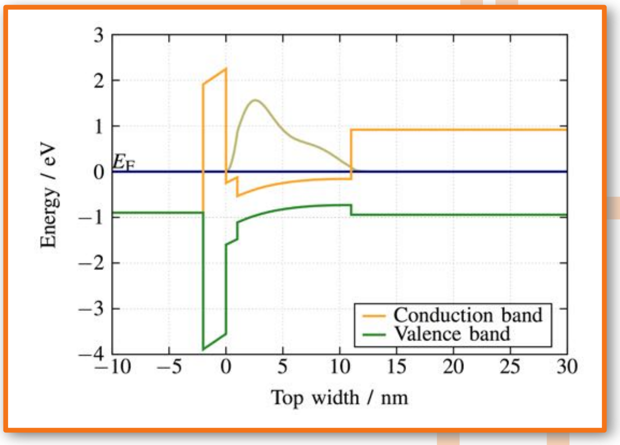
Self-consistent quantum correction ensures that carriers are confined to the InGaAs/InP-channel layers.



Resulting transfer characteristics

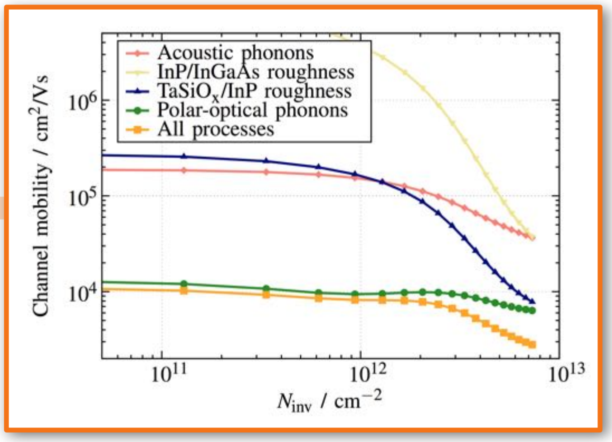
Sub-threshold slope 73.5mV/dec, DIBL 103.8mV/V

Structure Level: Microscopic Transport (VSP)



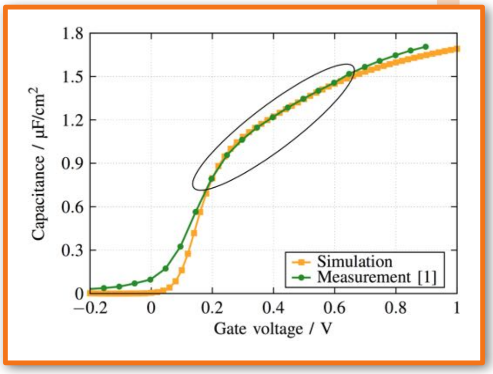
Electronic structure

Multi-valley effective mass approach with non-parabolic correction.



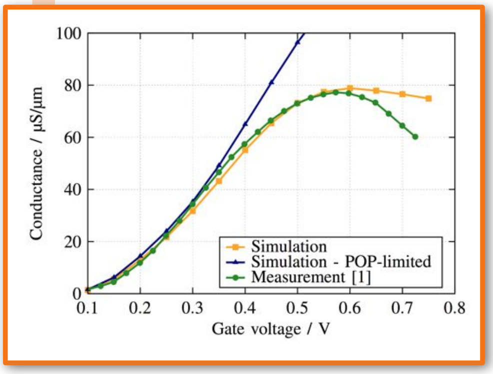
Electron mobility calculation

Includes all relevant scattering mechanisms, allowing to analyze and compare their influence.



Material parameters

Due to the unknown properties of the TaSiOx gate-dielectric, the dielectric constant and gate work function were calibrated against measured capacitance-voltage curves using our automated parameter fitting environment.



Transport model verification

Excellent agreement between measured and simulated channel conductivity is achieved on the first attempt without further parameter adjustments.

Scattering mechanisms considered for mobility:

- Acoustic phonons
- Polar optical phonons
- Non-polar optical phonons
- Surface roughness
- Impurities

Why rely on artificial parameters if one can build on physical values?

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Predictions based on physics.

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