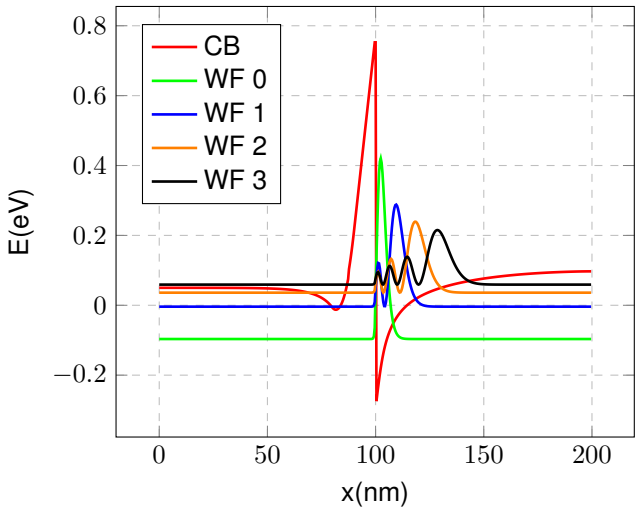
Xiences

Two dimensional electron gas

Classical Drift Diffusion



Xiences GmbH

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Executive Summary

This is a document describing an example project for the **XienceSim** software.

Note The XienceSim environment is a Finite element software package designed to solve complex physical problems. It is capable to handle 1,2 and 3 dimensional structures, with various analysis types: stationary, periodic, time dependent, eigenvalue. We hope that you are going to

nd our tutorial useful, comments are well appreciated: info@xiences.com.

Editor: Zoltan Jehn

1 Introduction

If we want to achieve high carrier concentration in a bulk semiconductor material we use most of the time sort of doping. But doping introduces higher scattering rate which can affect the performance of our device negatively. In order to achieve high carrier densities with low scattering rate at the same time we can use remote-doping, which induces high carrier concentrations even further away from the dopant atoms.

2 Band structure

We simulated the structure depicted in figure 1, with the labeled geometrical parameters. The higher band-gap material (*AlAs*) is doped in such way that it bands the band profile so, that the carrier concentration becomes larger in the undoped *GaAs* region.

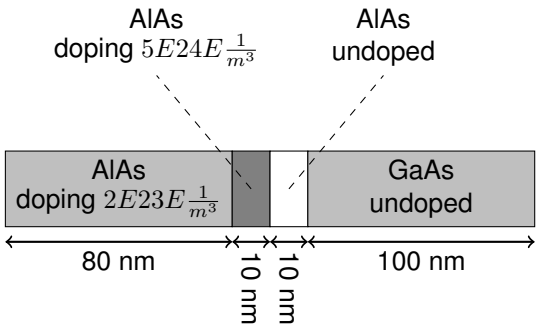

Figure 1: Schematics structure of the simulated layer structure

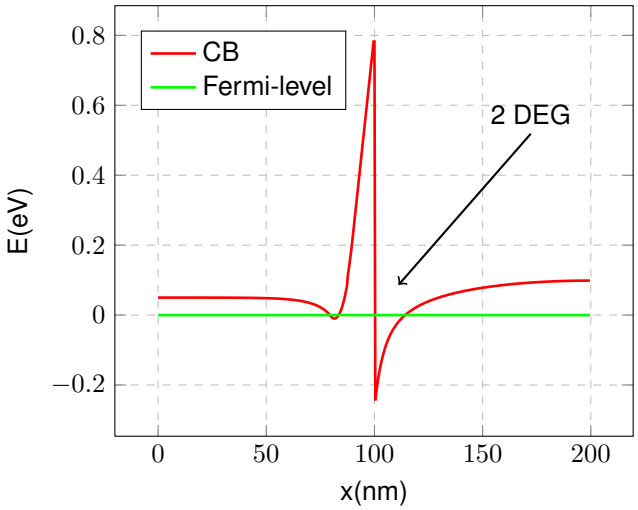

Figure 2: Conduction-band profile

The conduction band-edge is plotted in figure 2 with the fermi-level from classical charge calculation.

3 Quantum confinement

We can calculate the electron density with simply assuming classical three dimensional DOS that it would be a bulk sample. Or we can include the quantum confinement effects, including the solution self consistently the Schrodinger-Poisson equation. The calculated wave-functions in the undoped GaAs region is plotted in figure 3.

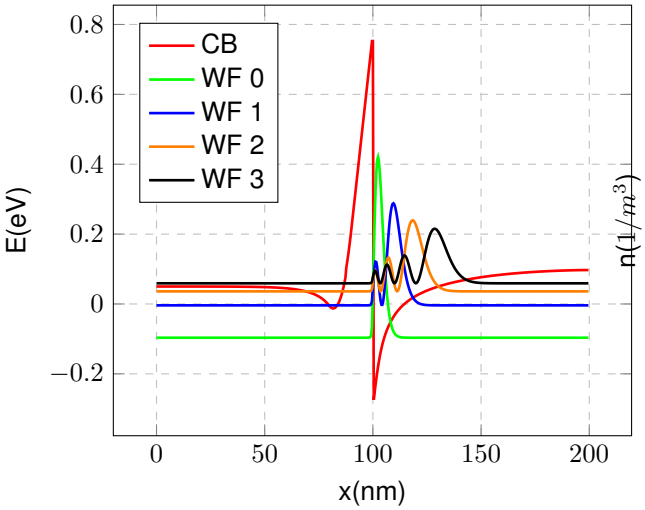

Figure 3: Electron wave-functions in the well

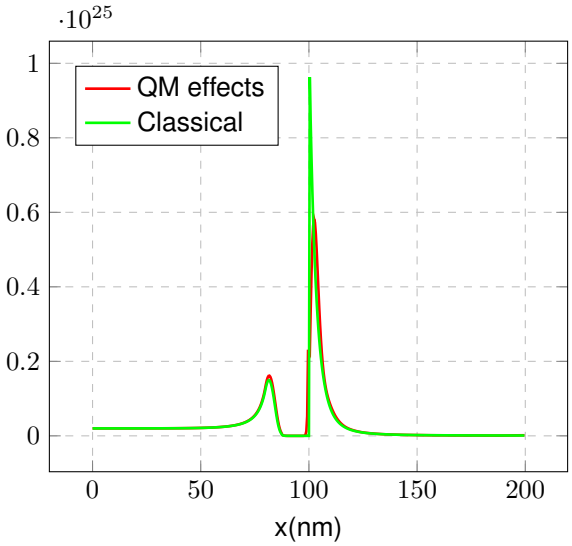

Figure 4: Electron density profiles

The electron density profiles in the sample are also compared in figure 4. It shows that including quantum mechanical effects the electron density is shifted in positive direction, while it gets wider.

4 Online materials

The full tutorial can be found at the website **http://xiences.com**, with example project files.

References