

Business idea

Software for the simulation of electronic and optoelectronic semiconductor nano devices and materials

Vision

“To establish nextnano³ as the de facto standard simulator for the next generation of semiconductor nano devices and materials.”

Founder

Stefan Birner, MPhys, has several years of international experience in the field of semiconductor simulation. Through competent partners at universities he has access to a large network of know-how in this field.

Partner

Prof. Dr. Peter Vogl
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Memberships

bayern photonics - Bavarian Competence Network for Optical Technologies, **Nanonetz** - Bavarian Nanotechnology Cluster, **NanOp** - Competence Centre for the Application of Nanostructures in Optoelectronics, **ENNaB** - Excellence Network NanoBioTechnology, **ENTA** - European Nanotechnology Trade Alliance

Applications

Quantum cascade lasers, quantum dots, Nano-MOSFETs, strained silicon, infrared detectors, ...

Disruptive technologies

nextnano³ acts in new markets: nanowires, bio chips, efficient solar cells, organic semiconductors, nanocrystals, gas sensors, spintronics, quantum cryptography, quantum computing

Project support

nextnano³ received financial support from the German Federal Ministry of Education and Research (BMBF).

Executive Summary

The business idea of nextnano³ is the development of software for the simulation of electronic and optoelectronic semiconductor nano devices and materials (*e.g.* transistors, resonant tunneling diodes, quantum dots, quantum wires, quantum-cascade lasers). Due to the continuing scaling of semiconductor electronics, quantum physical effects are gaining importance and confront the industry with fundamental challenges with respect to simulation and design. Existing tools cannot cope with these challenges and alternatives are not in sight.

Our unique selling proposition is a better physical method for the calculation of the **quantum mechanical properties** of an arbitrary combination of geometries and materials, *i.e.* nextnano³ is not limited to certain types of devices and thus perfectly suited for both, currently existing devices and novel devices, like for instance protein sensors (bio chips).

Our customers benefit from faster (time-to-market) and cheaper development of devices.

nextnano³ is a spin-off of the Walter Schottky Institute of the Technical University of Munich, Germany.

Customers

Our customers are the research labs of the leading semiconductor companies. So far we had successful projects with **Lucent Technologies** (Bell Labs) and **Infineon Technologies** on quantum-cascade lasers, quantum wells and quantum dots. Numerous top-notch universities are among our customers, like MIT, Princeton, Oxford, Cambridge, Technion, Tokio, Fraunhofer Institute.

Customers' benefits

- better understanding of device physics
- systematically improve and optimize devices
- less redesign cycles (optimum prototype)

Customer feedback

“One reason nextnano³ is so good at nanoelectronics is that it was not designed for nanoelectronics. It was designed to do physics.”

Postal address

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- **3D quantum dot** (pyramidal shaped quantum dot)

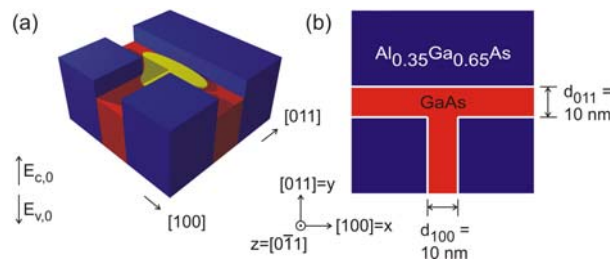


Left: Cut through the quantum dot: The bright line represents a layer of three atomic layers of InAs. Below this InAs layer the substrate material GaAs is located. The different lattice constants of GaAs and InAs lead to strain which causes self-organized growth of quantum dots. The InAs pyramid is surrounded by GaAs.

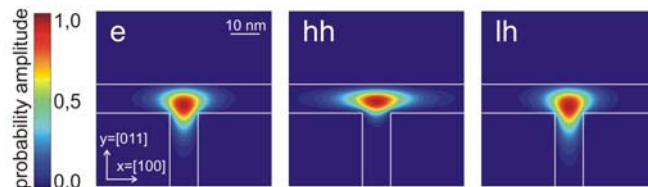
(bright colors: compressive strain, dark color: tensile strain – as calculated with nextnano³.)

Right: Due to the strain, strong piezoelectric fields arise at the edges of the pyramid which affect the optical properties of the dot.

- **2D quantum wire**

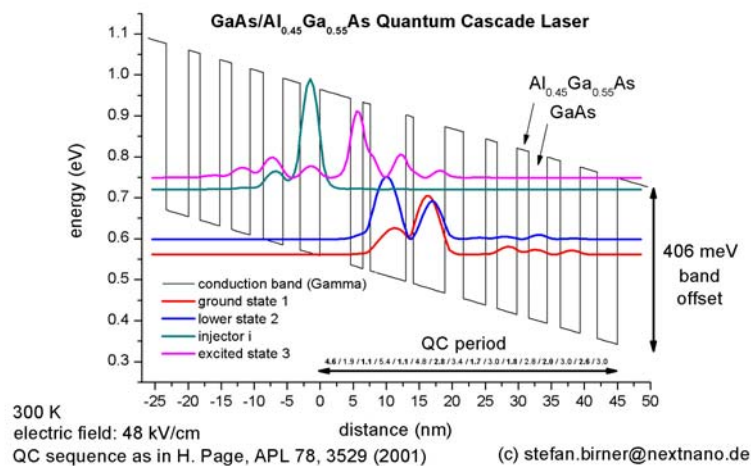


The figure on the left (a) shows schematically the conduction band profile of a T-shaped quantum wire. The schematic on the right (b) shows the relevant dimensions and materials.



In this figure the calculated wave functions of the electron (e), heavy hole (hh) and light hole (lh) are shown.

- **1D quantum wells** (quantum-cascade laser)



Conduction band structure of a quantum-cascade laser including the most important electron wave functions.