nextnano
Software for semiconductor nanodevices

2020-November-01

# PhD Position

## Multiband quantum transport in III-Sb based devices

3 year position, starting April/May/June 2021, net salary 25.000 €/year

For our Innovative Training Network in

**Quantum Semiconductor Technologies exploiting Antimony (QUANTIMONY)**

(www.quantimony.eu) that provides high-level training to early stage researchers in the field of III-Sb semiconductor science and technology, we are seeking a theoretical physicist that will work on quantum transport in interband cascade devices using the nonequilibrium Green's function method (NEGF).

Your responsibilities

- Simulation of interband cascade lasers, LEDs and detectors
- Closely interacting with the consortium partners and travel to project meetings
- Providing support to PhD students in this ITN that are using the nextnano software
- 4 secondments at University of Würzburg (Germany), University of Lancaster (UK), University of Rome (Italy) and TU Berlin (Germany) – each lasting 2 months
- Contributing to the development of our nextnano software
- Submitting a PhD thesis

Your qualifications

- Master degree in Physics or Electrical Engineering with relevant experience in Theoretical Solid State Physics, Semiconductor Physics and Quantum Mechanics
- Programming Skills
- Excellent, open-minded, entrepreneurial and team-spirited


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Consortium members

- Consejo Superior de Investigaciones Científicas (CSIC): Instituto de Micro y Nanotecnología (IMN) & Instituto de Ciencia de Materiales de Madrid (ICMM), Madrid, Spain (Coordinator)
- Universidad Politécnica de Madrid, Spain
- Lancaster University, UK
- The University of Warwick, Coventry, UK
- Technische Universiteit Eindhoven, Netherlands
- Technische Universität Berlin, Germany
- Julius-Maximilians-Universität Würzburg, Germany
- Università degli Studi di Roma "Tor Vergata", Rome, Italy
- Aixtron SE, Herzogenrath, Germany
- IQE plc, Cardiff, UK
- nextnano GmbH, Munich, Germany
- Partner Organizations: Bruker AXS (Germany), nanoplus GmbH (Germany), Lancaster Materials Analysis Ltd (UK), TiberLab Srl (Italy), QuantCAD LLC (USA), Fluxim AG (Switzerland), Lund University (Sweden), European Synchrotron Radiation Facility (Grenoble, France) National Synchrotron Radiation Research Center (NSRRC)-Taiwan Photon Source (Taiwan), Cardiff University (UK), Universidad de Cádiz (Spain), Universidade Federal de Sao Carlos (Brazil)

Further information: https://cordis.europa.eu/project/id/956548

nextnano GmbH develops software for the simulation of electronic and optoelectronic semiconductor nanodevices for research & development in academia and industry. It is a spin-off from the Walter Schottky Institute of the Technische Universität München and was founded in 2012. Our software is used by thousands of researchers in more than 35 countries. Our office is located in the AGENDIS Business Center Konrad at the historic site of Munich's former airport "München-Riem" (Wappenhalle) in Messestadt Riem next to the exhibition center "Messe München".

To find out more, please contact Dr. Stefan Birner, stefan.birner@nextnano.com, www.nextnano.com

Applications must be submitted via the website www.quantimony.eu from 2020-12-01 to 2021-01-31.

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## ESR14 Job Description

## Multiband quantum transport in III-Sb based devices

**Research Topic:**

**Why:** Interband cascade lasers (ICL) are semiconductor heterostructures consisting of a periodic repetition of atomically thin quantum wells and barriers. ICLs emit in the mid-infrared spectrum and are used for environmental gas sensing. The exact understanding of the microscopic details of the quantum transport properties in the active region is complicated and not completely understood but essential in order to further optimize these devices. For modeling the quantum transport properties of quantum cascade lasers (QCL), the nonequilibrium Green's function (NEGF) method is state of the art. However, it has never been applied to interband cascade lasers so far.

**What:** The modeling of the electronic states in these devices requires a multiband k.p model and depends very sensitively on the thickness and material composition of the layers. The objective is to develop a multiband model of nonequilibrium Green's functions calculating quantum transport and optical properties of III-Sb devices, applicable to III-Sb ICLs, memory arrays and type-II superlattices.

**How:** The candidate will extend our existing NEGF software for quantum cascade lasers by adding the valence bands within an 8-band k.p model so that electron and hole transport can be treated on an equal footing. This will include an accurate description of conduction band to valence band tunnelling which is the most challenging part of ICL devices. The developed software will also be applied to model type-II superlattices and memory devices. With these new features and the knowledge generated, the improved nextnano software will greatly facilitate the design and optimization of these III-Sb quantum devices and accelerate their commercialization.

**Environment:**

**Institution:** nextnano GmbH develops and sells software for the simulation of electronic and optoelectronic semiconductor nanodevices for both academic research and industrial research and development. Examples include nanotransistors, LEDs, laser diodes, photodetectors, quantum dots, nanowires, quantum cascade lasers and solar cells. The focus is on the simulation of the quantum mechanical properties of such devices. The nextnano software is used by more than 250 customers in more than 35 countries.

**Location/City:** nextnano GmbH is located in Munich, Germany. One employee is based in Grenoble, France.

**Requirements:**

We seek an excellent, open-minded, entrepreneurial and team-spirited PhD candidate with:

**Graduation:** a Master in Physics or Electrical Engineering with focus on theoretical physics (solid state physics, semiconductor physics, quantum mechanics)

Previous experience in a research environment involving semiconductor physics will be positively considered.

**Other:** The successful candidate should have excellent knowledge of solid-state theory, semiconductor physics and programming skills. Excellent communication skills and ability to work in an international environment will be strongly appreciated.