BSc/MSc project

NanoElectronics Group www.nano-electronics.nl

Title: *Single-charge carrier tunneling in silicon ambipolar quantum dots*

Supervisor: *Chris Spruijtenburg (PhD student), Sergey Amitonov (post-doc)*

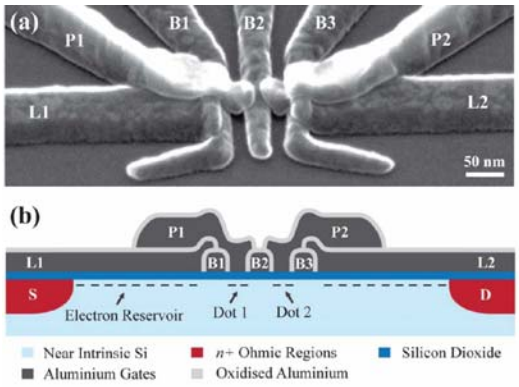

Fig.: Scanning electron microscope image (top) and a schematic side-view (bottom) of a 3-layer silicon double quantum dot. A two-dimensional electron gas (2DEG) at the Si/SiO_2 interface is induced by the lead gates L1 and L2. By locally depleting the 2DEG - using barrier gates B1, B2, and B3 - two quantum dots are formed between the barriers.

Goal and motivation

One of the proposed schemes to do quantum computation is creating quantum bits (qubits) with the spin of single electrons on quantum dots. Understanding how single electrons behave and tunnel through these single or double quantum dots is essential to create e.g. quantum logic gates. Because our quantum dots are formed in the electron sea of a solid (Silicon) a lot of fundamental and practical effects have a role: from disorder in our structure to whether we use electrons or holes as a carrier of charge and spin. We aim to investigate these properties at very low temperatures and see the fundamental physics at play.

The assignment

Your tasks may include all the essential steps from the bare Si wafer up to interpreting the measured data of the final device:

- *Fabrication of various quantum dot structures using our high-end cleanroom equipment in the NanoLab (including photolithography, electron beam lithography, electron beam evaporation, plasma-enhanced chemical vapour deposition, reactive ion etching)*
- *Characterization of the as-produced devices (using e.g. high-resolution scanning electron microscopy, atomic force microscopy, ellipsometry)*
- *Measurement of various quantum dot structures at cryogenic conditions (below 50 mK) in our cutting-edge dilution fridge using our specially built electronic equipment*
- *Analysing transport and quantum effects in quantum dots.*
- *Investigate electron-hole (a)symmetry, tunneling and/or even quantum state decoherence*

The focus of these tasks for your MSc project can be adjusted according to your affinities and skills.

Profile

You should have a background in nanotechnology, (applied) physics or electrical engineering or a related field. If you like to be part of a young, international team and you are motivated to learn and discover new interesting physics, then you are a perfect candidate for us.

Graduating in NE

As a student in NE you are a full group member and expected to give an active contribution to ongoing research. You are involved specific aspects of research (device fabrication, measurements and analysis). Besides you are also encouraged to participate in the regular social activities.

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