HL 15: Devices

Time: Monday 11:15–13:00  Location: ER 164

HL 15.1 Mon 11:15 ER 164
Disposable DotFET: Overlay requirements and the accuracy of E-Beam lithography on structures defined by optical lithography

Nanotechnology on microstructures for gas sensing applications

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Strained silicon enhances carrier mobility and therefore has drawn increasing attention for application in MOSFET devices. While wafer size processes for SiGe pseudosubstrates need either thick epilayer layers or sophisticated processing, the ordered growth of Ge dots only needs a proper marker layout that the requirements can be fulfilled by using a proper marker layout and the process, which will conserve the markers.

To utilize the strain it is indispensable to align the active area of the device on the Ge dot. In the European project D-DotFET the seedholes are defined by optical lithography, while for critical overlay steps, such as the source and drain extensions and the gate, e-beam lithography is used. To ensure an accurate overlay it is necessary to investigate the single components for their overlay accuracy and the accuracy of the interplay of the components. Furthermore it has to be examined, if the influence of the process will hamper the overlay accuracy.

Results for the overlay accuracy for the D-DotFET process show that the requirements can be fulfilled by using a proper marker layout and the process, which will conserve the markers.

HL 15.2 Mon 11:30 ER 164
SnO2-nanostructures for gas sensing applications

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Gas sensors based on nanocrystalline SnO2 films and single-crystalline SnO2-nanowires have been developed. The films with a thickness of 30-100 nm are fabricated by a spray pyrolysis process on SiO2-coated Si-substrates and processed in arrays of parallel bars, which are connected on both ends by ohmic metal contacts. The operating mode is based on a change in the electrical conductance along the SnO2-bars due to reducing or oxidizing gases. The sensors are operated at 200-400°C, show high sensitivity to humidity and are able to detect CO down to a concentration of 5 ppm. The SnO2-nanowires are fabricated by tempering 150-300 nm thick SnO2 films at temperatures of 800-1000°C. This process results in growth of SnO2-nanowires with 30-400 nm diameter and length up to several 100 µm. TEM analysis proved the single crystallinity of the nanowires. The SnO2-nanowires are deposited on SiO2-coated Si-substrates and contacted by means of photolithography. Investigations of the sensor performance of nanowires in comparison to nanocrystalline SnO2 films are in progress.

HL 15.3 Mon 11:45 ER 164
Si-based vertical MOSFETs for high temperature applications

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The operation of a MOSFET at high temperatures is limited by the collapse of the p-n-junctions due to the increase of intrinsic carriers. High doping concentrations may extend the temperature range, but the reduced space charge zone leads to Zener tunneling. Isolating the channel by two intrinsic zones (n⁺ip⁻in⁺structure for n-channel MOSFET) decrease the tunneling probability and furthermore allows the use of higher doping concentrations.

A commercial LPCVD-system was used for the deposition of n⁺ip⁻in⁺-structures, characterized by SIMS. For IV-measurements the epitaxy stacks were structured using reactive ion etching, passivated and metalized. Leakage currents were compared to a standard n⁺p⁻n⁻structure at different temperatures. First attempts have been made for an application of the n⁺ip⁻in⁺ stack in vertical MOSFETs.

HL 15.4 Mon 12:00 ER 164
Carbon Nanotube Field-Effect Transistors Probed by

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Carbon nanotube field-effect transistors (CNFETs) have attracted substantial interest due to their potential use in (opto)-electronics. For instance, CNFETs have been shown to display photoconductivity, thus being interesting for light detecting devices. On the other hand, despite the rapid development on the understanding and performance of CNFETs, several issues are still to be investigated in more detail, such as the carbon nanotube (CNT)-metal interfaces, and the spatial origin of their photoconductivity response. Scanning photocurrent microscopy (SPCM) has been shown to be a potentially powerful tool to characterize CNFETs. Strong photocurrent responses are typically observed at the contacts, resulting from the Schottky barriers. Moreover, the ability to spatially resolve the photocurrent responses, enables the investigation of CNT photoconductivity in more detail.

This contribution reports on SPCM characterization of field-effect transistors based on CNTs. Photocurrent images are obtained for zero and non-zero drain-source biases. It is demonstrated that the close relationship between the photocurrent response and the local electric field, enables the mapping of the electrostatic potential profile through SPCM characterization. Finally, it is shown that the photoconductive response does not occur homogeneously within the device.

HL 15.5 Mon 12:15 ER 164
Towards an electrically driven single photon source


To realize applications like quantum cryptography electrically driven, efficient single photon sources are necessary. We present a concept of an electrically driven, quantum dots based single photon device, which is furthermore compatible with a high quality resonator like a photonic crystal and should therefore allow high extraction efficiencies.

The quantum dots are pumped optically via a light emitting diode (LED) which is monolithically integrated underneath the quantum dot layer. The wavelength of the photons emitted by the LED can be adjusted to resonant or non-resonant excitation of the quantum dots. For high efficiency it is necessary to shift the emission of the quantum dots into the mode of the photonic crystal. This can be done by a Schottky contact in reverse bias. Thus an electrical field at the location of the quantum dots can be generated and shift the wavelength of the emission because of the quantum confined Stark effect. Hence the wavelength of the quantum dots can be modified independently of the pumping process. First measurements show the feasibility of our concept to realize a single photon device.

HL 15.6 Mon 12:30 ER 164
InGaN MQW laser diodes with cleaved facets on sapphire and bulk GaN substrates

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The development of AlN-based GaN laser diode has gained tremendous interest due to various applications ranging from optical data storage to laser displays. For reasons of cost and availability, nitride based laser diodes are commonly grown on c-plane sapphire substrates. However, there is a large misalignment between the sapphire and GaN cleave planes typically leads to the formation of steps and terraces in the laser facets, resulting in a deterioration of the laser performance. In this talk we will present a novel method in order to reproducibly obtain high quality facets for lasers grown on (0001) sapphire substrates. Based on a laser scribing process we were able to fabricate gain-guided laser diode with smooth facets which showed threshold current densities of 7.5 kA/cm² at an emission wavelength of 405 nm. Furthermore, we transferred this
technique to lasers grown on bulk GaN substrates which reduced the threshold current density to 4.5 kA/cm$^2$. A comparison of the performance characteristics of these laser diodes including threshold current densities, emission spectra and differential quantum efficiency will be provided.

Electrical characterization of SONOS-structures for non-volatile memories

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Silicon-oxide-nitride-oxide-silicon layers (SONOS) in the form of MOS-capacitors and MOS-transistors are investigated. The oxide/oxynitride films are deposited by chemical vapor deposition. Both the film thickness and the deposition parameters are varied. The devices are characterized by temperature- and time-dependent capacitance–voltage-measurements and current–voltage measurements. In particular, we have verified the memory effect of the structures. The data retention was studied to characterize the storage traps and to analyze the dominant discharge mechanism. The results show that the discharge depends almost logarithmically on time and is temperature-dependent. From our investigations it is evident that several mechanisms influence the discharge process. At present, only a qualitative characterization of the defects is possible.