HL 24 Bauelemente

Zeit: Samstag 10:45–12:30 Raum: TU P-N229

HL 24.1 Sa 10:45 TU P-N229

Ultrafast carrier dynamics in an InAs quantum-dot amplifier emitting at 1.3 μm — •Sabine Dommers[1], Stephan Schneider[1], Ulrike Woggon[1], Paola Borri[2], Wolfgang Langbein[3], Thorsten Kettler[4], Matthias Lämmlin[4], and Dieter Bimberg[4] — [1]Universität Dortmund, Otto-Hahn-Str. 4, 44221 Dortmund, Germany — [2]School of Biosciences, Cardiff University, Main Building, Park Place, Cardiff CF10 3TL, UK — [3]Department of Physics and Astronomy, Cardiff University, 5 The Parade, Cardiff CF24 3YB, UK — [4]Institut für Festkörperphysik, TU Berlin, 10623 Berlin, Germany

InAs quantum-dot amplifiers (QDA) can show improved performances over well or bulk devices. The investigated QDA with a ground-state (GS) emission wavelength of 1.3 μm is appealing for optical communication technology. We measure the ultrafast carrier dynamics at the GS and the linewidth enhancement factor (LEF) α at room temperature. The QDA is a p-i-n narrow ridge waveguide structure with InAs quantum-dots in the active region. Using differential transmission spectroscopy, with heterodyne detection, absorption/gain and refractive index dynamics are studied. The LEF α is determined from measurements of the modal gain g and the refractive index Δn. Resonant to the GS the LEF α is 0.02 for low bias current and becomes zero or even negative for higher transition energies [1]. These results are promising for low chirp operation and supression of beam filamentation. We also find that the gain recovery dynamics is suitable for signal processing at high bit-rates with recovery time constants of some ps [2]. [1] S. Schneider et al. IEEE J. Q. El. 40, 1423 (2004) [2] P. Borri et al. IEEE J.Sel.Top. Q. El. 8, 984 (2002)

HL 24.2 Sa 11:00 TU P-N229

Measurement of overlay accuracy of E-beam generated patterns for the fabrication of vertical gate all-around transistors — •Jürgen Moers, Andre van der Hart, and Hans Lüth — Institute of Thin Films and Interfaces and Center for Nanoelectronic Systems for Information Technology, Forschungszentrum Jülich, D-52425 Jülich

The scaling of MOSFET devices will go on at least for the next 15 years. This downsizing will lead to severe short channel effects, which have to be answered by new device architectures. The most promising candidates for end of roadmap MOSFETs are multigate devices such as FINFET, triple-Gate FET or vertical gate all-around FET. All of these MOSFETs show a proper control of the electric field in the channel area. However, for all these advanced MOSFETs, different patterns have to be aligned with an overlay accuracy of a few ten nanometers.

In this work, we present an overlay accuracy measurement method based on optical moire pattern: In three adjacent areas two overlaying gratings of period p_1 and p_2 are defined in two lithography steps: In the first area, the gratings are both defined in the first step, in the second area they are completely defined in the second step and in the third area p_1 is defined in the first step and p_2 in the second step. The three arising moire patterns have a phase difference according to their alignment shift: While the difference between the first and the second is due to statistical errors during the lithography (normally very small), the phase difference to the third area is attributed to the overlay error and hence a clear measure of it. The method is applied to a vertical gate all-around MOSFET process and overlay errors can be measured with an accuracy of less than $4nm$.

HL 24.3 Sa 11:15 TU P-N229

Fabrication and characterization of a vertical resonant tunneling diode in the sub-100nm range — •Jakob Wensorra[1], Mihail Ion Lepsa[1], Klaus Michael Indlekofer[1], Arno Förster[2], and Hans Lüth[1] — [1]Institut für Schichten and Grenzflächen (ISG1) und Center of Nanoelectronic Systems for Information Technology (CNI), Forschungszentrum Jülich GmbH, 52425 Jülich — [2]Fachhochschule Aachen, Abteilung Jülich, Physikalische Technik, Ginsterweg 1, 52428 Jülich

With the help of electron beam lithography and using high resolution Hydrogen Silsesquioxan (HSQ) as mask material, vertical GaAs/AlAs resonant tunneling diodes (RTD) with lateral dimensions down to 50nm have been realized. For contacting the nanostructures, a novel non-alloyed ohmic contact on a very thin low-temperature-grown GaAs (LT-GaAs) top layer has been developed. By means of DC electrical measurements, the dependence of the I-V characteristics on the device dimension has been analyzed. Here, the electronic transport properties are strongly influenced by the lateral depletion region, which defines the vertical conductive channel within the device. In the I-V characteristics, a clearly pronounced region of negative differential conductance has been observed at room temperature, down to 50nm lateral dimensions.

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Investigation of Electrical and Optical Properties of BaxSr1-xO Gate Oxide MIS Structures — •OLIVER KERKER[1], JAN ZACHARIAE[2], FARRUKH MIRZA[1], RÜDIGER FERRETTI[1], and KARL HOFMANN[1] — [1]Institut für Halbleiterbauelemente und Werkstoffe, Universität Hannover, Appelstr.11a, 30167 Hannover — [2]Institut für Festkörperphysik, Universität Hannover, Appelstr.2, 30167 Hannover

This investigation focuses on MIS structures with the (amorphous or crystalline) high-k dielectrics BaxSr1-xO. These high-k dielectrics are highly hydrophilic and degrade by the formation of hydroxides. Different metal oxide and nitride films are investigated as diffusion barriers and gate electrodes which are deposited by reactive sputtering and PECVD. The thermodynamic and chemical stability and morphology after RTA treatments of complete MIS capacitors are characterized by electrical measurements like tunneling leakage current (I(V)) and by SEM. Complete MIS gate stacks are analyzed by spectroscopic ellipsometry for the determination of complex dielectric functions, thickness of films, refractive indices and optical band gaps. Diffusion barriers are characterized for qualitative compositional surface analysis by XPS and for band structure determination by EELS.

HL 24.5 Sa 11:45 TU P-N229

A novel photo-conductive detector for single photon detection — •R. Schmidt[1], M. Vitzethum[1], S. Malzer[1], P. Kailuweit[2], D. Reuter[2], A. Wieck[2], and G.H. Döhler[1] — [1]Technische Physik I, Universität Erlangen-Nürnberg — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum

We present the concept of an ultra sensitive photo-conducting detector that should be particularly suitable for single-photon detection. It basically represents a p-i-n diode and junction FET integrated into a single device. Extremely high detectivity can be achieved by reducing the electrically active area of the device to the intersection point of two narrow perpendicular doping stripes. Therefore the capacitance of the detector reaches values lower than 0.1 fF, whereas the optical detection area is not reduced. The buried bottom stripe is written by a Focussed ion beam (FIB) directly into GaAs and is then overgrown by the following MBE-layers. The top stripe can be easily defined by wet-chemical etching.

The extremely low capacitance of our device implies charging voltages in the mV-range per photo-generated electron hole pair, leading to a persistent increase in the top-channel current of up to 10 nA. First experimental results show that room temperature dark currents at a few volts reverse bias are in the low pA- and capacitances in the low fF-range. The expected large photo-conductive gain is observed.

HL 24.6 Sa 12:00 TU P-N229

MOSFETs with high-k dielectrics Al_2O_3 and Pr_2O_3 — •Bernhard Fabel, Michael Oswald, Martin Sterkel, and Walter Hansch — Institute for Technical Electronics, Technical University Munich, Arcisstr. 21, 80333 Munich, Germany

MOS devices were fabricated and characterized for optimisation of high-k materials properties and fabrication conditions and compared to reference MOSFETs with SiO_2 gate dielectric. In the reference MOSFETs SiO_2 ($d_{Ox} \approx 25\,\mathrm{nm}$) as gate dielectric and aluminium metal gate were implemented and characterized. Approving the reproducibility of these devices the SiO_2 was replaced by the promising high-k candidates aluminium oxide Al_2O_3 and praseodymium oxide Pr_2O_3. Al_2O_3 was deposited by atomic layer deposition (ALD) at 300°C and 1 mbar. Pr_2O_3 was evaporated in ultra high vacuum in a molecular beam epitaxy (MBE) system at room temperature. Capacitance and conductance measurements were used to extract the following MOS parameters: dielectric constant ϵ_r, interface state density D_{it}, flatband voltage shift ΔV_{FB}. The breakthrough field E_{BD} could be determined by measuring the current density. MOSFETs transfer characteristics lead to the values of thresh-

old voltage shift ΔV_{Th}, channel mobility μ, subthreshold swing S, I_{on} and I_{off} current. Due to the data of the reference devices, it is possible to evaluate the high-k device and material properties by comparing the extracted parameters.

HL 24.7 Sa 12:15 TU P-N229

A new opto-electronic device: A polarisation-sensitive, intensity-independent switch for $1.3\mu m$ — •Stefan Krämer[1], J. Spieler[1], S. Malzer[1], S. Neumann[2], W. Prost[2], F.J. Tegude[2], and G.H. Döhler[1] — [1]Technische Physik I, Universität Erlangen-Nürnberg — [2]Halbleitertechnik, Universität Duisburg

Under specific growth conditions the quaternary semi-conductor InGaAsP forms a monoatomic superlattice in $[111]_B$-direction, similar to some ternary materials. These ordered materials exhibit a strong absorption anisotropy for light polarised in [110] or [1-10] direction at near-bandgap photon energies. The quaternary InGaAsP, lattice-matched to InP, is particularly appealing for photonic device applications, as its bandgap can be adjusted to the standard wavelengths for optical communication ($1.3\mu m$ and $1.55\mu m$). We use the optical anisotropy for a polarisation-dependent opto-electrical switch. It consists of a strongly polarization dependent photo-FET-diode with ordered $1.3\mu m$ InGaAsP in the active region, which is grown on top of a polarization-independent reference-diode with disordered $1.5\mu m$ InGaAsP in the absorbing layer. The absorption layer thicknesses are designed such, that depending on polarisation the photocurrent in the reference diode is larger or smaller than in the photo-FET-diode. Accordingly, almost the whole voltage drops either on the photo-FET- or on the reference-diode, whence the n-channel conductance is either "off"or "on"depending on the polarisation. Switchting is observed for 100nW $< P_{Laser} <$ 1.5mW with $I_{on} =$ 10mA, practically independent on the laser power. The switching contrast ranges between 3 and 7 orders of magnidude, depending on P_{Laser}.