HL 39: Silicon-based Semiconductors II

Time: Tuesday 14:45–15:45 Location: H14

HL 39.1 Tue 14:45 H14

Doping of 4H-SiC with group IV elements — •Maximilian Rühl[1], Tomasz Sledziewski[1], Günter Ellrott[1], Theresa Palm[1], Heiko Weber[1], Michael Krieger[1], and Michel Bockstedte[2,3] — [1]Department of Physics, Applied Physics, FAU Erlangen-Nürnberg, Germany — [2]Department of Physics, Solid State Theory, FAU Erlangen-Nürnberg, Germany — [3]Department of Chemistry and Physics of Materials, Universität Salzburg, Austria

An enhancement of the electrical conductivity of 4H-SiC was achieved recently by in-situ germanium doping [1]. Since Ge behaves isoelectrically in SiC, a Ge-related modification of the defect equilibrium was suggested. Here we combine experiment and theory to reveal the underlying physics. Our analysis of n-type 4H-SiC samples implanted with Ge or tin (Sn) by deep level transient spectroscopy (DLTS) shows that the mobility-limiting $Z_{1/2}$ center can be strongly reduced with increasing implantation dose. Simultaneously new defects are formed which are assumed to be Ge-/Sn-related. Using hybrid density functional theory we investigate the electronic properties and abundance of Ge-related defects. We find that the most abundant ones are the electrically inactive substitutional center at the Si-site (Ge_{Si}), the deep substitutional center at the C-site (Ge_C), and a complex with a carbon vacancy (Ge_{Si}-V_C). The Ge_{Si}-V_C complex can be associated with new defect centers observed in DLTS. Our combined approach suggests that kinetic effects drive the observed reduction of $Z_{1/2}$ (=V_C , [2]).

[1] Sledziewski *et al.* Mater. Sci. Forum **778-780** (2014) 216.
[2] Kawahara *et al.* J. Appl. Phys. **115** (2014) 143705.

HL 39.2 Tue 15:00 H14

LDOS matching in nanophotonic cavities using position-defined quantum dots — Magdalena Schatzl, •Florian Hackl, Martin Glaser, Moritz Brehm, Reyhaneh Jannesari, Friedrich Schäffler, and Thomas Fromherz — Institute of Semiconductor and Solid State Physics, Johannes Kepler University, A-4040 Linz, Austria

Si integrated optics is an absolutely required next step for the implementation of data rates currently required in data storage centers and in near future also for inter- and intra-chip communication. As a technologically less demanding alternative to hybrid integration of III-V material based emitters into a SOI based integrated optical platform, the monolithic integration of group IV based emitters for the telecom wavelength region is highly attractive. While for coherent radiation strained Ge, SnGe and glassy QD based lasers have been demonstrated recently, as emitter on the single photon level SiGe quantum dots combined with ultra-high Q nano-optical cavities are promising candidates. In our work, we combine site controlled growth of SiGe QDs with L3 type photonic crystal resonators defined by e-beam lithography for a systematic study of the influence of the QD position within the cavity on the photoluminescence efficiency. Using a series of identical cavities, each containing a single QD at accurately and systematically varied positions, by these experiments we map out the photonic local density of states (LDOS) of several optical cavity modes and demonstrate that by placing the QD at the correct position, we are able to control the emission mode of QDs.

HL 39.3 Tue 15:15 H14

Tellurium hyperdoped Si: Flash lamp annealing vs. pulsed laser melting — •Mao Wang[1,2], Fang Liu[1,2], Ye Yuan[1,2], Slawomir Prucnal[1], Yonder Berencén[1], Lars Rebohle[1], Wolfgang Skorupa[1], Manfred Helm[1,2], and Shengqiang Zhou[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstr. 400, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

Chalcogen-hyperdoped silicon has been a topic of great interest due to its potential optoelectronic applications owing to the sub-band gap absorption [1-3]. In our work, tellurium hyperdoped Si was fabricated by ion-implantation with different fluences ranging from 1.09*1015 to 1.25*1016 cm-2 followed by two kinds of ultra-short annealing processing: flash lamp annealing (FLA) and pulsed laser melting (PLM). The Raman spectroscopy results reveal the high-quality recrystallization of tellurium implanted Si by both FLA and PLM. From the transport measurements, the conductivity increases with increasing tellurium concentration. High tellurium concentration samples show a finite conductivity as temperature trend 0. This indicates that the high concentration doping of tellurium induces an insulator-to-metal transition in Si although Te introduces a deep donor in Si.

[1] Kim, T. G., et al., Appl. Phys. Lett. 88, 241902 (2006) [2] Tabbal, M., et al., Appl. Phys. A 98, 589*594 (2010) [3] Umezu, I., et al., J. Appl. Phys. 113, 213501 (2013)

HL 39.4 Tue 15:30 H14

Disentangling Surface from Bulk Conductivity by Distance-dependent Four-Probe Transport Measurements Combined with an Analytical Conductance Model — •Sven Just[1], Helmut Soltner[2], Stefan Korte[1], Vasily Cherepanov[1], and Bert Voigtländer[1] — [1]Peter Grünberg Institut (PGI-3) and JARA-FIT, Forschungszentrum Jülich — [2]Central Institute for Engineering, Electronics and Analytics (ZEA-1), Forschungszentrum Jülich

Distance-dependent four-probe measurements performed with a multi-tip scanning tunneling microscope (STM) allow to distinguish between 2D and 3D charge transport channels. In combination with a conductance model for mixed 2D-3D geometries, a disentanglement of surface transport from bulk contributions and a determination of the surface conductivity is possible. Often a very simple parallel circuit model of surface and bulk is used, but it has a very limited applicability due to the rough approximation of only two layers. So, an analytical model for charge transport in N layers is derived from the solution of Poisson's equation, which e.g. can be used for semiconductors in combination with a calculation of the near-surface band-bending to model very precisely the measured four-point resistance on the surface. By applying this model to published data on Ge(001), Si(100) and Si(111) with different doping concentrations, the surface conductivity of these materials can be determined without any further needs of special sample preparation. Furthermore, this generic approach for determining surface conductivity can be easily applied to other material systems, e.g. to topological insulators.