
Here, we present and discuss the formation and charge storage properties of readily produced oxide embedded NCs and their potential use in new generations of light emitting diodes, fast and stable solar cells. Although intensive research has been conducted regarding the photoluminescence and charge storage properties of readily produced oxide embedded NCs, little is known about the phase separation and NC formation process. Here, we present in and ex situ X-ray absorption near edge structure (XANES) spectroscopy data of the temperature induced disproportionation, i.e. phase separation of GeO$_2$ ($x \approx 1$) into Ge and GeO$_2$, which leads to the formation of Ge NCs embedded in a GeO$_2$ matrix. The formation of size controlled Ge NCs is achieved using a GeO$_2$-SiO$_2$ superlattice approach. The influence of reducing hydrogen in the annealing ambient on the phase separation process and resulting NC density is discussed.

Structural modifications of low energy heavy ion irradiated Ge — Tobias Steinbach, Jan Wierzbecki, and Werner Wiesch — Institute of Solid State Physics, Friedrich Schiller University Jena.

During LEI irradiation of germanium extreme structural changes can be observed. To study the effects and the mechanism of porous layer formation in Ge in more detail samples were irradiated with different ion species, ion energy and angle of incidence. In order to increase the penetration depth, irradiations were performed with ion energies in the range of several MeV. We present ion induced morphological changes in Ge over a wide range of ion fluence $N_f$, beginning with the amorphization process of c-Ge followed by the formation of voids in the amorphous phase and its transformation into a porous structure at high $N_f$. Depending on $N_f$ different regimes of porous layer formation are observed (SEM and TEM investigations) and we could demonstrate that the rate of the volume expansion depends only on nuclear energy deposition $\epsilon_n$. However, the formation depth of the voids as well as the shape and the dimension of the porous structure depend on the ion species (chemical properties of the irradiated ions) and irradiation temperature, respectively. Investigating the different regimes of ion irradiations a formation of a microstructure at the surface occurs whereas for non-perpendicular ion irradiation a plastic deformation, i.e. a surface shift, without a microstructure formation was observed. The effect of plastic deformation will be discussed in detail and provides an explanation for the different surface structures observed for different ion incidence.

Structure characterization on selective Ge CVD-heteroepitaxy on free standing Si (001) nanopatterns — Grzegorz Kozlowski, Peter Zausche, Yuh Yamamoto, Joachim Bauer, Bernd Tillack, and Thomas Schröder — IHP, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany.

Ge is attracting increasing interest to build up future photonic technologies. The main reasons for choosing Ge is given by its superior optoelectronic properties with respect to Si and its compatibility with Si CMOS processing in contrast to III-V materials. The major stumble block for the integration of high quality Ge films on Si is however given by the 4.2% lattice mismatch which causes misfit and threading dislocations (TD). It is known that Ge deposited in smaller window tends to form an amorphous phase and its transformation into a porous structure at high N$_f$. Depending on N$_f$, which gives rise to n-type and p-type effects is the charge redistribution that occurs between the dopant and its neighbors, as we illustrate here using electronic structure calculations. This view point is able to explain why conventional substitutional n-type doping of carbon has been so difficult.

Extrinsic doping in silicon revisited — Udo Schwingenschlögl, Alexander Ch Knoxville, Cosima Schuster, and Robin Grimnes — 1IPSE Division, KAUST, Thuwal 23955-6900, Kingdom of Saudi Arabia, 2Department of Materials, Imperial College London, London SW7 2BP, United Kingdom — 3Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany.

Both n-type and p-type doping of silicon is at odds with the charge transfer predicted by Pauling electronegativities and can only be reconciled if we no longer regard dopant species as isolated atoms but rather consider them as clusters consisting of the dopant and its four nearest neighbor silicon atoms. The process that gives rise to n-type and p-type effects is the charge redistribution that occurs between the dopant and its neighbors, as we illustrate here using electronic structure calculations. This view point is able to explain why conventional substitutional n-type doping of carbon has been so difficult.

In-situ incorporation and distribution of boron dopants in silicon nanowires

In the context of semiconductor devices, the in-situ incorporation and distribution of boron dopants in silicon nanowires (Si NWs) are of significant interest. This is because Si NWs, with their high aspect ratio and small diameter, present unique opportunities for the development of new electronic devices. The incorporation of boron dopants is crucial for controlling the electrical properties of these nanowires, which can be crucial for applications ranging from nanoscale transistors to photovoltaic devices.

The research focuses on understanding how drift and diffusion of injected charge carriers in intrinsic electric regions and of the electric fields across them is discussed. It is explained how the nonuniformity in active boron concentration is related to the in-situ doping process itself which can offer different pathways for incorporation of boron.

15 min. break

Kelvin probe force microscopy on doped semiconductor nanostructures with local, carrier-depleted space charge regions

The Kelvin probe force microscopy (KPFM) technique is a powerful tool for imaging the electric potential distribution on surfaces and interfaces. In this study, KPFM is used to investigate the electrical behavior of doped semiconductor nanostructures, specifically focusing on the local, carrier-depleted space charge regions. This technique allows for the visualization of the electric field distribution, which is essential for understanding the electrical properties of these materials.

The measurements reveal a superposition of contributions from different gap states. A thermal cleaning procedure is used to resolve different levels, we have analyzed the incorporation, distribution and deactivation of active boron concentration than the thicker (around 70 nm) inner core. We further establish that this nonuniformity in active boron concentration is related to the in-situ doping process itself which can offer different pathways for incorporation of boron.

Contact materials for sulphur hyperdoped black silicon

The use of black silicon as a photovoltaic material has gained significant interest due to its unique properties, such as the ability to absorb a wider range of wavelengths compared to conventional silicon. However, the use of sulphur hyperdoped black silicon as a contact material presents unique challenges. In this study, various contact materials such as silver, titanium/palladium/silver, chromium/gold, and transmetals like silver, titanium/palladium/silver, chromium/gold are compared using techniques like screenprinting, sputtering, pulsed laser deposition and thermal evaporation.

The use of such low cost substrates limits process temperatures to values below 600°C which strongly influences the electrical and structural properties of the material. In particular, the performance of electronic devices containing poly-Si is affected by grain boundaries, inclusions and lattice defects that cause localized states in the band gap. These defect states can trap charge carriers and can act as efficient recombination centers limiting the performance of thin-film transistors and solar cells. Thermally stimulated current measurements (TSC) are a helpful tool to detect these states in poly-Si films on Corning glass which are produced by electron beam evaporation and subsequent solid phase crystallization. The measurements reveal a superposition of contributions from different gap states. A thermal cleaning procedure is used to resolve the individual components. Six states with activation energies ranging from 116 meV to 543 meV are obtained. The results are discussed in terms of possible intrinsic and extrinsic defects.

Determination of the complex refractive index in the infrared region for femtosecond-laser-formed silicon surfaces using ray-tracing

The femtosecond-laser processing of silicon surface in the SF6 gas creates cone-shaped structures, which have a thin 0.1 - 1 μm layer of multi-crystalline substance with approximately 0.5 at.% of sulphur. This layer is known to form a thin 0.1 - 1 μm layer of multi-crystalline substance with approximately 0.5 at.% of sulphur. This material can be deposited on cheap substrates such as glass or plastic. However, the use of such low cost substrates limits process temperatures to values below 600°C which strongly influences the electrical and structural properties of the material. The measurements reveal a superposition of contributions from different gap states. A thermal cleaning procedure is used to resolve the individual components. Six states with activation energies ranging from 116 meV to 543 meV are obtained. The results are discussed in terms of possible intrinsic and extrinsic defects.

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in the infrared and simulating ray-traces in the coned surface, allows calculating the complex refractive index and the associated absorption coefficient. The simulated refractive index spectra are presented for samples processed in SF6 gas and vacuum in the wavelength range 1100 nm - 2500 nm. The obtained absorption coefficient spectra for samples processed in SF6 are of the order of $10^{-4}$ cm$^{-1}$. This high absorption in the infrared is discussed from the point of view of the introduced sub-band-gap energy levels on the one hand and high free carrier absorption on the other hand.