O 50: Semiconductor Substrates: Structure, Epitaxy, Growth and Adsorption

Time: Tuesday 18:30–20:30 Location: P1A

O 50.1 Tue 18:30 P1A

Mask aligner for shadow mask evaporation of nanostructures — •Simon Mathioudakis, Priyamvada Bhaskar, Tim Olschewski, Marcus Liebmann, Marco Pratzer, and Markus Morgenstern — II. Inst. Phys. B and JARA-FIT, RWTH Aachen University, Germany

In order to arrive at an experiment for detecting Majorana fermions using scanning tunneling microscopy, we aim at evaporating superconductors with pierced holes onto a topological insulator $((\mathrm{Bi}_{x-1}\mathrm{Sb}_x)_2\mathrm{Te}_3)$. This structure is produced by evaporating the superconductor through a shadow mask. The goal is an in-situ process of creating an array of pierced holes and thus keep the interface free of resists or residues. Therefore, a mask aligner operating in ultrahigh vacuum (UHV) is developed. It uses three piezo-drives to align the mask relative to the sample. Three capacitive sensors are used to determine the sample-mask distance down to a precision of 100 nm each. This technique has been successfully tested and as a first proof, gold has been evaporated onto HOPG and Si substrates. AFM and SEM characterizations reveal an edge width below 100 nm, however also indicate assymetry in the deposited holes due to a drift during evaporation.

O 50.2 Tue 18:30 P1A

Hydrogen etching of SiC(0001): Route to an epitaxy template — •Maximilian Bauernfeind, Felix Reis, Victor Rogalev, Marius Will, Ralph Claessen, and Jörg Schäfer — Physikalisches Institut and Röntgen Center of Complex Material Systems (RCCM), Universität Würzburg, 97074 Würzburg, Germany

The hexagonal (0001) surface of silicon carbide offers a huge playground for the epitaxy of a variety of different materials. An intriguing aspect is the growth of honeycomb lattices made of high-Z elements, such as Sn or Bi, predicted to exhibit topological protected edge states. To enable successful epitaxy of such materials, one has to focus on the substrate quality, and prepare defect-free and well-ordered flat surfaces. In-situ gas phase etching in a hydrogen atmosphere makes it possible to achieve these required qualities.

Here we demonstrate the effects of different etching parameters studied by scanning tunneling microscopy. The results are analyzed regarding large-scale terrace formation and defect density. In general, the etched substrate surface becomes hydrogen-passivated which, however, impedes the bonding of the admitted high-Z atoms. One approach to hydrogen desorption from SiC(0001) discussed in the literature is a photoinduced process with synchrotron UV light.

In addition, we present the succesful thermal desorption of hydrogen and the formation of a dangling bond (DB) state, as inspected by photoemission. The surface density of the DB state is analyzed in an annealing study. This finally renders SiC as a versatile growth template.

O 50.3 Tue 18:30 P1A

Halbleiterheterostrukturen - Analyse und Interpretation kapazitätsspektrokopischer Messungen — •Martin von Sprekelsen und Wolfgang Hansen — Jungiusstraße 9, 20355 Hamburg

Mit Rasterkapazitätsmikroskopie können Ladungsträgerkonzentrationen bei fester Probenbias-spannung abgebildet und daraus Rückschlüsse auf zugrundeliegenden Dotierungsprofile gezogen werden. Bei heterogenen Halbleitern wird die räumliche Lage von Dotierungsübergängen mit Hilfe der Rasterkapazitätsspektroskopie ermöglicht. Messungen und Verfahren werden vorgestellt.

O 50.4 Tue 18:30 P1A

Reaction channels of methanol on Si(001) studied by means of STM and XPS — •Patrick Kirsten, Christian Länger, and Michael Dürr — Institut für Angewandte Physik, Justus-Liebig-Universität, 35392 Giessen

Adsorption of organic molecules on silicon typically proceeds via an intermediate state. For diethyl ether, e.g., a dative bond between oxygen and silicon is formed in this intermediate, which was isolated at low surface temperatures on Si(001)[1]. A similar adsorption via a datively bonded intermediate state is proposed for alcohols on Si(001), however, the proton transfer associated with the transition from the intermediate into the final state is expected to proceed much faster than the energetically less favourable ether cleavage [2].

Indeed, when we performed XPS measurements after adsorption of methanol on Si(001) at different surface temperatures, the C 1s and O 1s spectra recorded both at 90 K and room temperature indicate dissociative adsorption and covalent bonding of the H atom and OCH$_3$ fragment. In STM images taken after adsorption at room temperature, the end-bridge adsorption configuration is predominant. Changes in the adsorption configurations with surface temperature are interpreted in terms of a precursor-mediated reaction channel.

[1] Reutzel, et al., J. Phys. Chem. C **119**, 6018 (2015).
[2] Kato, et al., J. Phys. Chem. B **105** 10340 (2001).

O 50.5 Tue 18:30 P1A

HREELS of Ammonia Adsorbed on a Water Reacted Si(001)-(2x1) Surface — •Niklas Fornefeld[1], Felicitas Scholz[1], Ulrich Köhler[1], Stefan Kubsky[2], and Francois Rochet[3] — [1]Arbeitsgruppe Oberflächenphysik, Ruhr-Universität-Bochum, Germany — [2]Synchrotron Soleil, St. Aubin (Paris), France — [3]Laboratoire de Chimie Physique Matière et Rayonnement, Univ. P. et M. Curie, Paris, France

Surface bound hydroxyl-groups on silicon surface became an interesting topic for research due to the use as interface between an anorganic and an organic semiconductor. To investigate the binding properties on those silanol-groups we studied the adsorption of ammonia (NH$_3$) as an example for a Lewis base. In order to determine the adsorption kinetics and geometry and the behavior during the process of unfreezing, we studied the NH$_3$/(H/OH)/Si(001)-(2x1) system with High Resolution Electron Energy Loss Spectroscopy (HREELS) in the temperature range between 100K and 300K.

We report the self-limited adsorption of molecular ammonia on surface silanols in a proton-acceptor geometry (ammonia giving its lone pair to Si-OH) below 140K. Around 160K the molecularly adsorbed ammonia desorbs within seconds. Taking temperature dependent spectra, the desorption kinetics was quantitatively determined. In addition, there are indications for the growth of a small amount of dissociated ammonia on isolated dangling bonds of the water covered surface.

O 50.6 Tue 18:30 P1A

As-modification of vicinal Si(100) surfaces for III-V-on-Si heteroepitaxy in CVD ambient — •Agnieszka Paszuk[1], Oliver Supplie[1], Sebastian Brückner[1], Peter Kleinschmidt[1], Anja Dobrich[1], Andreas Nägelein[1], Matthias M. May[2], and Thomas Hannappel[1] — [1]Institute of Physics, Technische Universität Ilmenau, Germany — [2]Department of Chemistry, Cambridge University, UK

Compound semiconductors grown on Si substrates are attractive for high efficiency solar cells, optoelectronic and microelectronic devices. Growth of III-V materials with low defect densities on Si is challenging due to lattice mismatch and different thermal expansion coefficients, as well as polar-on-nonpolar epitaxy. Arsenic (As) enables growth of ternary compounds, such as GaAsP, and As is mostly present in application-relevant III-V MOCVD reactors. We previously showed that dedicated As-modification of the heterointerface is suitable to control the III-V sublattice orientation [1]. Here, we will study the dimer orientation on vicinal Si(100) surface prepared in As-rich MOCVD ambient. The entire process is controlled by in situ reflection anisotropy spectroscopy (RAS) and the obtained RA spectra are benchmarked by LEED and XPS. We show that the RAS signal is not only terrace-related (As-coverage, type and orientation of the dimers) but it also can contain contributions from the step structure. We achieve in situ control of the majority dimer orientation on As-modified Si(100) surfaces and can thereby choose the sublattice orientation of the subsequently grown, single-domain III-V epilayer. [1] A.Paszuk et al., APL 106, 231601 (2015); O. Supplie et al., APL Mater.3,126110 (2015).

O 50.7 Tue 18:30 P1A

Adsorption of acetone on TiO2 rutile(110) — •Jessica Kräuter, Milena Osmić, and Katharina Al-Shamery — Carl von Ossietzy University of Oldenburg, 26129 Oldenburg, Germany

For increasing selectivity and activity of heterogeneous catalysts it is necessary to get a fundamental understanding of the interactions between adsorbate and catalyst. Therefore, as a model system for chemical reactions the adsorption of aldehydes/ketones on a common catalyst like TiO_2 rutile(110) is studied. Recently, an influence of the temperature dependent mobility of bulk defects on the reductive coupling of benzaldehyde was concluded from own work.[1] In previous coverage dependent studies on the ketone acetone and co adsorbed molecular oxygen the occurrence of a diolate species has been identified on a medium reduced rutile single crystal at liquid nitrogen temperatures.[2,3] Here we present the influence of bulk defects from studies on temperature dependent adsorption of acetone co adsorbed with molecular oxygen and oxygen ad atoms. On a more strongly reduced rutile single crystal a diolate species can be observed even without oxygen co adsorption. Furthermore, in TPRS an additional surface species appeared from 235 to 274 K when co adsorbing acetone with molecular oxygen which has not been reported before. Changes of the molecular orientation of acetone on the surface were also proven by polarization dependent IRRAS measurement. [1] P. M. Clawin, C. M. Friend, K. Al-Shamery, A European Journal, 2014, 90, 7665. [2] M. A. Henderson, J. Phys. Chem. B, 2008, 108, 18932. [3] N. G. Petrik, M. A. Henderson, G. A. Kimmel, J. Phys. Chem. C., 2015, 119, 12273.