O 10.1 Mon 13:15 MA 042

Thickness-dependent structural investigation of thin GaN films by Photoelectron Diffraction

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Thin films of hexagonal gallium nitride have been grown on 6H-SiC by ion-beam assisted MBE. The thickness ranges from submonolayers to more than 100 monolayers. The samples were characterised by XPS, LEED and XPD. During growth, different types of wetting layers were observed: (i) a Ga metal wetting layer on the SiC substrate and (ii) a Ga metal wetting layer on top of the growing GaN film.

The differences between Ga2p and Ga3d emission have been evaluated, with Ga3d photoelectrons being bulk sensitive while Ga2p photoelectrons are probing the surface. Features evolving with thickness are identified and interpreted. The experiments are supported by multiple scattering cluster calculations, showing clear indications of increasing bands with increasing film thickness. The simulations also allow for determining the polarity of the films, which is found to be Ga-terminated for all samples.

O 10.2 Mon 13:30 MA 042

Morphological and chemical characterization of thin heteroepitaxial Praseodymium sesquioxide films on Si(111)

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Among the rare earth Praseodymium oxides possess the highest oxygen mobility and a high oxygen storage capability. Due to this fact they are promising candidates for catalytic applications exploiting the variable valency of Pr. A simplified two dimensional model system of the oxide catalyst can be prepared on silicon substrates in a UHV environment to study the atomic details of oxygen transport and transfer when exposed to adsorbed molecules. Here we report on the growth and morphology of heteroepitaxial Pr2O3 films at a low deposition rate on Si(111) which were investigated using Spot Profile Analysis of Low-Energy Electron Diffraction. In the initial stages of growth the specular diffraction spot exhibits a pronounced threefold symmetry most likely reflecting the formation of highly ordered islands of triangular shape as shown by STM. A roughening of the substrate surface is observed during growth of the initial Praseodymium oxide layer. Beyond these morphological studies, preliminary results of a first chemical characterization of the films with and without adsorbates (CO and oxygen) by XAS and XPS will be presented.

O 10.3 Mon 13:45 MA 042

Combined electrical and chemical characterization of BaO thin films on Si(001)


In contrast with the search for alternative gate oxides on SiO2 in CMOS technology, we have grown high-k BaO films at a thickness between 5 and 20 nm on clean Si(001) using molecular beam epitaxy of Ba metal in ambient oxygen pressure. Interface states and color centers were characterized by XPS and EELS while varying temperature and oxygen partial pressure during growth. For the electrical measurements, Si(001) has been pre-structured by optical lithography and BaO was only generated on small squares using a tungsten mask. After preparation, the films were cycled with 250nm of Au and electrically characterized ex situ. From capacity-voltage measurements on known areas of BaO windows, a dielectric constant of 30 was calculated. This means that for a 5nm BaO film corresponds to an equivalent oxide thickness (EOT) of 0.65 nm of SiO2. These measurements also show very low hysteresis (<5mV), and flatband voltages are close to that of the workfunction difference between Si and Au (+0.65 eV). These results are encouraging in terms of the concentrations of fixed and mobile oxide charges both in the bulk and at the interface. The influence of different defects at the interface and within the BaO films will be discussed.
ically influences the oscillation damping. Under consideration of an Ehrlich-Schwoebel barrier, the rate model quantitatively reproduces experimental oscillation damping as function of growth temperature and speed. Furthermore, the presence of an Ehrlich-Schwoebel barrier explains the more strongly damped oscillations during GaAs growth in comparison to AlAs. AlAs has a higher energy barrier for surface diffusion but a lower Ehrlich-Schwoebel barrier. From a quantitative analysis we obtain values of the Ehrlich-Schwoebel barrier height for GaAs of 0.134 eV and AlAs of 0.069 eV.

O 10.7 Mon 14:45 MA 042
Investigation of a long-ranged ordered silicate adlayer on the 6H-SiC(0001) surface by LEED, AES and IPE — ∗NAX AGHDASSI, RALF OSTENDORF, and HELMUT ZACHARIAS — Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Straße 10, 48149 Münster

We have prepared well-ordered silicate adlayers on 6H-SiC(0001) surfaces by an ex situ hydrogen treatment at elevated temperatures. The generated surfaces appear to be fully passivated and therefore stable in ambient air. LEED patterns clearly feature a \((\sqrt{3} \times \sqrt{3})\)R30\(^\circ\) periodicity which can be attributed to a long range order of the created oxide layers. Furthermore AES spectra exhibit a distinct O\(_{KLL}\) peak as well as a Si\(_{2p}\) peak showing a typical oxidic-like shape that is indicating the presence of Si-O bonds on the surface. The unoccupied electronic states of the SiO\(_2\)/SiC interface are studied by inverse photoemission spectroscopy (IPES).

O 10.8 Mon 15:00 MA 042
Optimized hydrogen bake as in-situ removal of residual oxide and carbon on silicon substrates for thin film deposition — ∗THOMAS ZILBAUER, PETER ISKRA, DOROTA KULCA-EGGER, MARTIN SCHLOSSER, HELMUT LOCHNER, TORSTEN SULIMA, and IGNAZ ESELE — Universität der Bundeswehr München, Institut für Physik, Werner-Heisenberg-Weg 39, 85577 Neubiberg

The removal of carbon impurities and the native or chemical oxide from silicon substrates is an increasingly important issue for the fabrication of nanoscale semiconductor devices. Often a last in-situ cleaning step is necessary to prepare the partly recontaminated substrate surface after thorough wet chemical cleaning for a deposition process such as CVD, ALD or MBE. Heating the substrate to temperatures above 800 °C in a hydrogen ambient leads to quick thermal desorption of the residual oxide. However, carbon impurities on the substrate may cause formation of stable silicon carbide at these elevated temperatures. We demonstrate results from optimizing the hydrogen bake of a commercially available cluster tool for silicon substrates with different history of wet-chemical pre-treatment. The oxygen and carbon contamination are analyzed by secondary ion mass spectrometry (SIMS). Additionally, I-V-measurements of epitaxially grown p-i-n diodes are used to evaluate the cleaning results.

O 10.9 Mon 15:15 MA 042
Impurity induced growth instabilities — ∗JÖRG MELOW and FRANK GROSSE — Institut für Physik der Humboldt Universität zu Berlin, Newtonstr. 15, 12489 Berlin, Germany

Growth instabilities can be utilized for the formation of semiconductor nanostructures, e.g. regular step bunches might be useful as templates for growth of quantum wires. A possible source for step bunching is the presence of Si-C or Si-O bonds on the surface. The unoccupied electronic states of the SiO\(_2\)/SiC interface are studied by inverse photoemission spectroscopy (IPES).

O 10.10 Mon 15:30 MA 042
Strain Induced Pit Formation in Ge Layers on Si(111) — ∗KONSTANTIN ROMYUK, VAŠILY CHIRPEPA, BERT VOGTSLANDER, and JACKE BRONA — 1Institute of Bio- and NanoSystems (IBN 3), and cni – Center of Nanoelectronic Systems for Information Technology, Research Centre Jülich, 52425 Jülich, Germany — 2Institute of Experimental Physics, University of Wrocław, pl. Maxa Borna 9, PL 50-204 Wrocław, Poland

When nanoscale Ge stripes are grown at Si step edges by step flow growth the formation of nanoscale pits in the one atomic layer thick Ge stripes is observed. This pit formation occurs in surfactant mediated (Bi) where Si atoms bind at the step edge as a small rim at the Ge stripes. As we will explain this nanoscale pit formation is driven by both, the energy gain when Ge leaves the Ge stripe and attaches to the thin Si rim terminating the Ge stripe, and the entropy gain due to SiGe intermixing at the step edges. While the direct vertical exchange would lead to a similar final state a high exchange barrier is involved. The pathway via pit formation involves a much lower exchange barrier.
linear dispersion of the \(\pi\)-bands at their crossing at the Dirac point. The opening of a gap as a function of the layer thickness and charge distribution can be observed by high-resolution photoemission experiments. However, the conditions and layer thickness required for the gap opening and the detailed values of gap size and Dirac energy shift are currently under debate. In the present communication we use scanning tunneling spectroscopy (STS) at low temperatures to obtain insight in the local electronic structure of mono- and bilayer graphene on SiC(0001). We show that already for the first graphene layer grown on top of the \((6\sqrt{3} \times 6\sqrt{3})R30^\circ\) buffer layer a gap opening is observed. The size of this gap, however, is varying with the periodicity of the interface structure, possibly due to a spatially dependent potential induced into the graphene layer. For the second layer we also observe the Dirac gap but no local spatial variation, i.e. the interface potential is too weak to modulate the electronic structure of the bilayer.

Graphene band structure near the Dirac point - lifting of the degeneracy?

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The band structure of graphene exhibits a degeneracy of the valence and conduction bands where the linearly dispersing bands cross at the Brillouin zone boundary [1]. In contrast to previous experimental evidence which strongly supports this band crossing, recent photoemission data by Zhou et al. [2] suggest that this degeneracy is lifted in graphene layers on SiC(0001), through the influence of the substrate, and that a band gap opens at the crossing point. We discuss these results in the light of additional results and present a straightforward and rather intuitive explanation for the conflicting results in terms of the quality of the graphene films prepared on silicon carbide.