HL 33: Ge/Si II

Time: Tuesday 9:30–11:15 Location: EW 015

HL 33.1 Tue 9:30 EW 015

Ion-beam mixing in crystalline and amorphous germanium isotope multilayers — •M. Radek[1], H. Bracht[1], R. Kube[1], M. Posselt[2], and B. Schmidt[2] — [1]WWU Münster — [2]HZDR

Self-atom mixing induced by Gallium (Ga) implantation in crystalline and amorphous germanium (Ge) is investigated using an isotopic multilayer structure of alternating ^{73}Ge and ^{nat}Ge layers grown by molecular beam epitaxy. The distribution of the implanted Ga atoms and ion-beam induced depth-dependent mixing was determined by means of the secondary ion mass spectroscopy (SIMS). The position and form of the implanted Ga peak is very similar in the amorphous and crystalline Ge and can be reproduced accurately by computer simulations based on binary collision approximation (BCA), whereas the ion-beam induced self-atom mixing strongly depends on the state of the Ge structure. The data from SIMS-measurements reveal a stronger mixing in the crystalline than in the amorphous Ge. Atomistic simulation based on BCA can reproduce the experimental data only if unphysically low displacement energies are assumed. The low displacement energies deduced within the BCA approach are confirmed by experiments with mixing induced by silicon implantation. The disparity observed in the ion-beam mixing efficiency of crystalline and amophous Ge indicates different dominant mixing mechanisms. We propose that self-atom mixing in crystalline Ge is mainly controlled by radiation enhanced diffusion during the early stage of mixing before the crystalline structure turns into an amorpous state, whereas in an already amoprhous state self-atom mixing is mediated by cooperative diffusion events.

HL 33.2 Tue 9:45 EW 015

A hydrogen-related luminescence band in p- and n-type germanium — •Matthias Allardt, Vladimir Kolkovsky, and Jörg Weber — Technische Universität Dresden, 01062 Dresden, Germany

The present work focuses on the photoluminescence (PL) studies in hydrogen-plasma treated p- and n-type germanium. After DC hydrogen plasma treatments in the temperature range 80 - 150 °C a new hydrogen-related luminescence band at 723 meV was observed in p- and n-type germanium. The intensity of the band decreases rapidly with temperature and disappears at around 15 K. No shift of the band was detected in the samples with different shallow impurities. The origin of the luminescence band will be discussed.

HL 33.3 Tue 10:00 EW 015

Probing local strain and composition in Ge nanowires by means of tip-enhanced Raman scattering — •Juan S. Reparaz[1,2], Niculina Peica[1], Ronny Kirste[1], Alejandro R. Goñi[2,3], Gordon Callsen[1], Markus R. Wagner[1], Maria I. Alonso[2], Miquel Garriga[2], I. Carmen Marcus[2], Isabelle Berbezier[4], Jannina Maultzsch[1], Christian Thomsen[1], and Axel Hoffmann[1] — [1]Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstr. 36, u o a 10623 Berlin, Germany — [2]Institut de Ciència de Materials de Barcelona-CSIC, Esfera UAB, 08193, Bellaterra, Spain — [3]ICREA, Passeig Lluís Companys 23, 08010 Barcelona, Spain — [4]IM2NP, CNRS - Univ. Aix Marseille, Campus St. Jèrôme, Case 142, 13397 Marseille Cedex 20, France

In this work we investigate local strain and composition in Ge nanowires using tip-enhanced Raman scattering (TERS). We will mainly focus on the influence of the tip on the NW's Raman spectrum, showing that the electromagnetic field enhancement due to the TERS effect allows to probe the local composition and strain in these nanostructures. A close comparison with what can be achieved using micro-Raman will be discussed, showing the great advantages of TERS over conventional far-field optical techniques. As a striking result we will show the presence of local vibrational modes (LVMs) of the GeGe mode in the presence of a Au rich enviroment which acts as catalyst for the NWs growth, are only observed using TERS. Finally, the dependence of strain and composition with the position along the NWs will be presented.

HL 33.4 Tue 10:15 EW 015

Electrical characterization of Ge nanodomes via AFM based techniques — •Markus Kratzer[1], Christian Prehal[1], Maria Rubezhanska[2], Sergey Kondratenko[3], Yury Kozyrev[2], and Christian Teichert[1] — [1]Institute of Physics, Montanuniversität Leoben, Franz Josef Straße 18, 8700 Leoben, Austria — [2]O.O. Chuiko Institute of Surface Chemistry, National Academy of Sciences of Ukraine, Kiev, Ukraine — [3]National Taras Shevchenko University, Physics Department, Kiev, Ukraine

Low-dimensional nanostructures like nanodots, nanowires, and nanodomes (NDs) have attracted scientific interest due to their potential application in electronics, optoelectronics, and photovoltaics. In this work, we report on the electrical characterization of single Ge nanodomes utilizing conductive atomic force microscopy (C-AFM), photoconductive AFM (PC-AFM), and Kelvin Probe force microscopy (KPFM). The Ge NDs were grown on Si(001) by means of molecular beam epitaxy (MBE) under ultra-high vacuum (UHV) conditions. The AFM measurements were performed under ambient conditions in dark and under illumination. Two-dimensional current maps revealed a higher conductivity of the NDs compared to the surrounding. Conductivity variations within single NDs could be observed, which will be discussed with respect to ND facets and strain-induced changes in the local density of states. Current-to-voltage (IV) measurements on individual NDs revealed a dependence of the IV characteristics on the ND size. Support in the framework of the Ukrainian-Austrian Project M/139-2007 is acknowledged.

HL 33.5 Tue 10:30 EW 015

Focused ion beam induced damage in germanium and synthesis of free-standing germanium nano-webs — •Rupert Langegger, Alois Lugstein, and Emmerich Bertagnolli — Institute of Solid State Electronics, Floragasse 7, A-1040, Vienna, Austria

Efficient light emitters compatible with standard CMOS technology have been a subject of research for more than a decade. The influence of strain and doping concentration on the efficiency of the luminescence in germanium has been already studied. To further comprehend processes in nanoscale regime we intensively investigated germanium under various conditions.

Germanium was irradiated with focussed Ga+-ions with a kinetic energy of 30 keV. The surface modifications as a function of angle of ion beam incidence, fluence and surface temperature has been investigated by scanning electron microscopy and AFM imaging. The photoluminescence-properties were investigated with a WITec alpha300 and an excitation wavelength of 532nm.

At room temperature physical sputtering was observed leading to ripples on the Germanium surface. At a substrate temperature of T=600°C physical sputtering was observed leading to flat bottomed boxes independent of the ion fluencies.

Furthermore we present an approach for focused ion beam induced synthesis of free-standing germanium nano-webs with a thickness below 20 nm and luminescence in the near-infrared region.

HL 33.6 Tue 10:45 EW 015

Tuning the Electronic Properties of Germanium Nanowires by Room Temperature Focused Ion Beam Implantation — •Clemens Zeiner[1], Alois Lugstein[1], Thomas Burchhart[1], Peter Pongratz[2], Justin G. Connell[3], Lincoln J. Lauhon[3], and Emmerich Bertagnolli[1] — [1]Institute for Solid State Electronics, TU Wien, Vienna, Austria — [2]Institute for Solid State Physics, TU Wien, Vienna, Austria — [3]Department of Materials Science and Engineering, Northwestern University, Evanston, Illinois, United States

Germanium nanowires (Ge-NW) have moved in the focus of the nanoscience community as promising candidates for novel quantum devices due to their favourable material properties. Our investigations show outstanding effects of FIB ion implantation into Ge-NW. The NWs are grown using a VLS process and contacted by electron beam lithography. Low resistivity contacts were formed by Cu diffusion forming Cu_3Ge/Ge-NW heterostructures with atomically sharp interfaces. By FIB implantation of 30 keV Ga and Bi ions at room temperature, the Ge-NW conductivity increases up to 3 orders of magnitude with increasing ion fluence without further annealing. Four point measurements prove that the conductivity enhancement emerges from the modification of the wires themselves. The Ga distribution in the implanted Ge-NWs was measured using atom probe tomography. Finally the feasibility of improving the device performance of top-gated Ge-NW MOSFETs by FIB implantation is shown.

HL 33.7 Tue 11:00 EW 015

Temperature induced phase separation and nanocrystal formation in bulk amorphous $Si_xGe_yO_z$ — •Alexander Nyrow[1], Christian Sternemann[1], Christoph Sahle[1], Achim Hohl[2], Kolja Mende[1], Marco Moretti Sala[3], Ralph Wagner[4], Alexander Schwamberger[1], Inge Brinkmann[1], and Metin Tolan[1] — [1]Fakultät Physik/DELTA, Technische Universität Dortmund, D-44221 Dortmund, Germany — [2]Institute for Materials Science, Darmstadt University of Technology, D-64287 Darmstadt, Germany — [3]European Synchrotron Radiation Facility, F-38043 Grenoble Cedex, France — [4]Fachbereich C -Physik, Bergische Universität Wuppertal, D-42119 Wuppertal, Germany

Since the discovery of the visible luminescence group IV semiconductor nanocrystals (NCs) obtained great attention during recent years. Due to the high efficiency of the luminescence, oxide matrix embedded Ge and Si NCs can be used as high efficient light emitting diodes or as fast and stable non-volatile memory devices. The band structure and thus the optical properties of the NCs depend very strongly on the NC size. Thus, bulk amorphous $Si_xGe_yO_z$ can serve as starting material for SiO_2 matrix embedded Ge NC production because (i) oxide embedded Ge NCs have a smaller band gap and a higher dielectric constant compared to Si NCs which results in higher charge retention times and (ii) Si is preferentially oxidized so that Ge NC formation can be tuned. In this study, temperature induced phase separation and NC formation have been investigated by x-ray diffraction, x-ray absorption near-edge spectroscopy and x-ray Raman scattering.