HL 4: II-VI semiconductors

Time: Monday 10:15–12:45 Location: POT 51

HL 4.1 Mon 10:15 POT 51

Monolithic distributed Bragg reflectors and microcavities lattice matched to ZnTe — •Wojciech Pacuski[1,2], Carsten Kruse[1], Stephan Figge[1], Tomasz Jakubczyk[2], Andrzej Golnik[2], Jan Gaj[2], and Detlef Hommel[1] — [1]Institute of Solid State Physics, University of Bremen, Postfach 330 440, D-28334 Bremen, Germany — [2]Institute of Experimental Physics, University of Warsaw, Hoza 69, PL-00-681 Warszawa, Poland

A distributed Bragg reflector (DBR) is a high quality mirror based on alternating layers with high and low refractive index. In a monolithic DBR made of semiconductors both layers should have the same lattice parameter, what makes the design and fabrication of such structures quite challenging. For the first time we present a monolithic distributed Bragg reflector with lattice parameter matched to ZnTe. It can be deposited on a ZnTe substrate with high crystalline quality.

Our DBRs were grown using molecular beam epitaxy (MBE) on a 1μm thick fully relaxed ZnTe buffer layer deposited on GaAs substrate. New materials presented in our work allow us to reach a high refractive index step $\Delta n = 0.5$. It results in a broad spectral stopband exceeding 60 nm width and in reflectivity coefficient as high as 99% (for only 15 DBR pairs). We are motivated by applications (e.g. lasers, detectors) for the orange and red spectral range; therefore our structures are designed for wavelengths close to 650 nm. In order to confirm the suitability of the structures for device applications, we realized a microcavity, which consists of a λ cavity sandwiched between two DBRs. It has a Q value exceeding 500.

HL 4.2 Mon 10:30 POT 51

Temperature dependent Raman scattering experiments of CdSe nanorods — •Patryk Kusch[1], Holger Lange[1], Mikhail Artemyev[2], and Christian Thomsen[1] — [1]TU-Berlin, Institut für Festkörperphysik, Berlin, Germany — [2]Institute for Physico-Chemical Problems, Belarusian State University, Minsk, Belarus

We present temperature dependent Raman scattering experiments of different sized colloidal CdSe nanorods. We monitor the dependence of the temperature on the longitudinal optical phonon (LO) related Raman band. The LO frequency shows a red shift with increasing temperature. This is consistent with a theoretical model from Balkanski et al.[1]. The exact influence of the sample temperature on the Raman spectra also depends on the nanorod geometry. The results are used to examine the interaction of phonon confinement and temperature effects. Furthermore the heat stability of the colloidal nanorods is investigated in order to examine their suitability for high temperature environments.

[1] M. Balkanski, R.F. Wallis and E. Haro, Phys. Rev. B28 (1983) 1928.

HL 4.3 Mon 10:45 POT 51

High temperature magnetic polaron formation in Mn-doped CdSe nanoparticles — Lars Schneider[1], •Gerd Bacher[1], Rémi Beaulac[2], Paul Archer[2], and Daniel R. Gamelin[2] — [1]Werkstoffe der Elektrotechnik und CeNIDE, Universität Duisburg-Essen, 47057 Duisburg — [2]Department of Chemistry, University of Washington Seattle, WA 98195-1700 (USA)

Transition metal doped semiconductor nanoparticles have attracted great interest because of their high application potential in spintronics and optoelectronics. E.g., doping with Manganese (Mn) can create interesting magnetooptical effects in CdSe nanoparticles [1]. Here we present time resolved photoluminescence (PL) measurements on size selected Mn-doped CdSe nanoparticles from the liquid phase. Nanoparticles with a mean particle diameter of 5nm and a Mn-content of 4.2% show at T = 5K a huge transient red shift of about 140 meV in contrast to less than 30 meV observed in CdSe reference nanoparticles of similar size. We attribute this to the formation of an exciton magnetic polaron (EMP)with a large internal exchange field. From the transient energy shift we are able to extract a characteristic time constant of 150 ps, which fits quite well to the magnetic polaron formation in self organized CdSe/ZnMnSe quantum dots [2]. Although the transient energy shift gets weaker with increasing temperature, a clear indication of magnetic polaron formation even above 200K is observed demonstrating the highest temperature ever obtained for EMP formation. [1]Beaulac et al., Nanoletters, 8 (2008), 1197. [2]Seufert et al., Phys. Ref. Lett., 88 (2002) 027402

HL 4.4 Mon 11:00 POT 51

Lifting of the fundamental cavity mode polarization degeneracy in CdSe/ZnSSe-quantum dot monolithic microcavities — •Moritz Seyfried, Joachim Kalden, Kathrin Sebald, Jürgen Gutowski, Arne Gust, Carsten Kruse, and Detlef Hommel — Institue of Solid State Physics, University of Bremen, P.O. Box 330 440, D-28334 Bremen, Germany

Lifting polarization degeneracy of the fundamental cavity mode in a quantum dot (QD)-based microcavity (MC) would allow to control the polarization state of the emitted photon in single-photon emitters. To realize devices in the blue to green spectral region, CdSe QDs were embedded in a monolithic ZnSSe based VCSEL structure grown by molecular beam epitaxy. Circular pillar MCs with diameters in the range from 500 nm up to 4000 nm were prepared by focused-ion-beam etching. Polarization dependent investigations of the fundamental cavity mode reveal a lifting of its degeneracy concerning the polarization. By an appropriate adjustment of the polarizer the two orthogonally polarized components of the fundamental mode can be observed individually with an energy splitting of up to 0.42 meV and quality factors of up to 7800. In any polarization orientation in between a superposition of both modes is detectable. Furthermore, an increase of the energy splitting with increasing pillar diameter is observed. As the MCs are nearly perfectly circular, a lifting of the mode degeneracy due to an elliptical cross-section of the pillars is very unlikely. Therefore, the existence of strain within the MCs as origin of the mode degeneracy is considered and tested by studying the influence of annealing.

HL 4.5 Mon 11:15 POT 51

High quality junctions by interpenetration of vapor liquid solid grown nanostructures for microchip integration. — Seid Jebril[1], Hanna Kuhlmann[1], Sven Müller[2], Carsten Ronning[3], Lorenz Kienle[4], Viola Duppel[5], and •Rainer Adelung[1] — [1]Funktionale Nanomaterialien, CAU Kiel, Kaiserstr. 2, D-24143 Kiel — [2]Nanowires and thin films, II. Physikalisches Institut, Friedrich-Hund-Platz 1, D-37077 Göttingen — [3]Institute for Solid State Physics, Universität Jena, Max-Wien-Platz 1, D-07743 Jena — [4]Synthese und Realstruktur, CAU Kiel, Kaiserstr. 2, D-24143 Kiel — [5]MPI für Festkörperforschung, Heisenbergstr. 2, D-70569 Stuttgart

The usability of nanostructures in electrical devices like gas sensors depends critically on the ability to form high quality contacts and junctions. For the fabrication of various nanostructures, vapor-liquid-solid (VLS) growth is a wide spread and very efficient technique. However, forming contacts with the VLS grown structures to utilize them in a device is still tedious, because either the substrate has to be epitaxial to the VLS material or a manual alignment is necessary. Here we demonstrate the contact formation by simply using the ability of individual crystals to interpenetrate each other during the straight forward VLS growth. This allows growing VLS structures directly on two neighboring gold circuit paths of a microchip; bridges over predefined gaps will be formed. Moreover, TEM investigations confirm the high quality of the crystalline junctions that allow demonstrations as UV and hydrogen-sensor. The VLS devices are compared with conventional produced [1] ZnO nanowires. [1] S. Jebril et al. Small,(2008)in press

15 min. break

HL 4.6 Mon 11:45 POT 51

Zeitaufgelöste Spektroskopie von magnetischen Polaronen in CdMnSe/CdMgSe Quantengräben — •Tillmann Godde[1], Irina I. Reshina[2], Sergey V. Ivanov[2], Ilya A. Akimov[1,2], Dmitri R. Yakovlev[1,2] und Manfred Bayer[1] — [1]Experimentelle Physik II, Technische Universität Dortmund, D-44221 Dortmund, Germany — [2]Ioffe Physical-Technical Institute RAS, 194021 St. Petersburg, Russia

Ein magnetisches Polaron beschreibt eine lokale ferromagnetische Ausrichtung, die aus der starken Wechselwirkung des magnetischen Moments eines elektrischen Ladungsträgers mit den Spins lokalisierter magnetischer Ionen resultiert. Die Dynamik eines magnetischen Exziton-Polarons wurde erstmals in semimagnetischen Cd-

MnSe/CdMgSe Quantengräben untersucht. Mittels zeitaufgelöster Photolumineszens-Spektroskopie auf einer Pikosekundenskala wurden die Abhängigkeiten der Bildungs- und Lebensdauer sowie die Energie des magnetischen Polarons in Magnetfeldern bis zu 7 T und bei Temperaturen von 1,9 bis 25 K bestimmt. Die Bildungsdauer der magnetischen Polaronen liegen in dem Bereich von 100-400 ps. Die Energie von 15 meV des Polarons wurde direkt durch eine selektive Anregungstechnik gemessen und durch weitere Methoden bestätigt.

HL 4.7 Mon 12:00 POT 51

Accelerated, two-staged spin-lattice relaxation in (Zn,Mn)Se quantum wells — •Jörg Debus[1], Vitalii Yu. Ivanov[2], Andrei A. Maksimov[3], Dmitri R. Yakovlev[1], and Manfred Bayer[1] — [1]Experimentelle Physik II, Technische Universität Dortmund, 44221 Dortmund, Germany — [2]Institute of Physics, Polish Academy of Sciences, 02668 Warsaw, Poland — [3]Institute of Solid State Physics, Russian Academy of Sciences, 142432 Chernogolovka, Russia

The dynamics of spin-lattice relaxation of the Mn ions in (Zn,Mn)Se-based diluted magnetic semiconductor quantum wells with low Mn concentration ($\leq 2\%$) is studied by time-resolved photoluminescence.

The quantum well magnetization is determined by single Mn ions as well as spin clusters with antiferromagnetically coupled Mn ions. Pair and triple clusters with next nearest neighbour ions acting as fast relaxing centers contribute to the energy transfer from the Mn system to the lattice via two-phonon Orbach transitions, resulting in a two-staged spin-lattice relaxation process. The efficiency of both processes is influenced by the Mn concentration, strength of applied magnetic field and optical excitation density.

A further impact of next nearest neighbour spin clusters on the spin-phonon interactions is revealed in cusps in the static and dynamic quantum well magnetization at specific magnetic fields below 10 T. The cusps correspond to an additional cooling of the Mn spin temperature due to a crossing of Zeeman-splitted cluster spin levels. Consequently, the emission of resonant phonons causes an acceleration of the spin-lattice relaxation.

HL 4.8 Mon 12:15 POT 51

Einfluss eines stöchiometriebedingten *p*-*n*-Übergangs auf die Diffusion in CdZnTe — •J. Kronenberg[1], F. Wagner[1], H. Wolf[1], Th. Wichert[1] und ISOLDE Collaboration[2] — [1]Technische Physik, Universität des Saarlandes, 66123 Saarbrücken — [2]CERN, PH Department, 1211 Genf

In früheren Studien wurde gezeigt, dass die Diffusion von Ag und Cu in CdTe ungewöhnliche Konzentrationsprofile aufweist [1]. Nach einseitiger Implantation und anschließender Diffusion unter Cd-Dampfdruck entsteht ein bzgl. der Probenmitte (Dicke ca. 800 μm) symmetrisches, peakförmiges Profil. Notwendig dazu ist Te-reiches, *p*-leitendes Material, das durch die thermische Behandlung unter Cd-Druck in Cd-reiches, *n*-leitendes Material umgewandelt wird. Liegen bei der Diffusionstemperatur die Dotieratome hauptsächlich als positiv geladene, hoch mobile Zwischengitteratome vor, so spiegelt das Konzentrationsprofil das Profil der Fermienergie wider. Dabei zeigen dessen Flanken die aktuelle Position des *p*-*n*-Übergangs zwischen Te reichem und Cd reichem Material an. Mittlerweile wurden auch für Au und Na in CdTe nahezu dieselben Eigenschaften beobachtet. Auch Co und Ni zeigen ungewöhnliche Diffusionsprofile, unterscheiden sich jedoch deutlich von denen für Ag, Cu, Na und Au. Die beobachteten kastenförmigen Profile reichen von der implantierten Oberfläche bis hin zum jeweiligen *p*-*n*-Übergang. Ursachen für die Entstehung der kastenförmigen Profile werden diskutiert.

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[1] H. Wolf *et al.*, Phys. Rev. Lett. **94** (2005) 125901

HL 4.9 Mon 12:30 POT 51

Homo- and heteroepitaxial growth of ZnS — •Udo Roemer, Stefan Lautenschlaeger, Sebastian Eisermann, Oliver Graw, Joachim Sann, Melanie Pinnisch, Andreas Laufer, and Bruno K. Meyer — Ist phisics institute, Justus Liebig University Gießen

ZnS in its zincblende structure has a direct bandgap of 3.6 eV at room temperature. As material for optoelectronic applications it possesses some advantages, for example the absence of crystal fields or piezoelectricity, compared to GaN or ZnO. So far there are only a handful of publications dealing the ZnS thin film growth, up to this work no homoepitaxial growth approach has been studied. We used both, ZnS single crystal substrates and GaP single crystal substrates to investigate the CVD growth of ZnS thin films. The grown epilayers have been studied using low temperature photoluminescence (PL), X-ray diffraction (XRD), Atomic Force Microscopy (AFM) and Secondary Ion Mass Spectroscopy (SIMS).