Wednesday Morning Poster Sessions, November 5, 2003

Semiconductors
Room Hall A-C - Session SC+EM-WeP
Poster Session

SC+EM-WeP1 STM Observation of Dopant Atoms and Point Defects in the p-type GaAs (110) Surface at 5K, *B. Grandidier,* ***G. Mahieu,*** *D. Deresmes, J.P. Nys, D. Stievenard,* IEMN-CNRS, France*; P. Ebert,* IFF-Julich, Germany

Cross-sectional scanning tunneling microscopy (STM) is used to study dopant atoms and point defects exposed on and in cleaved p-type doped GaAs (110) surfaces at 5K. While Zn dopant atoms have been already characterized in the past, spatial mapping of the conductance variation on individual dopants gives new insights in the origin of the triangular shaped features generally observed if the tip Fermi level is near the bottom of the conduction band. Combining empty and filled state images, we also identify As antisites and complex of vacancies. The stability of complex vacancies are discussed in the light of the available theoretical information.

SC+EM-WeP3 Metal-Oxide-Semiconductor Field Effect Transistors Investigated by Scanning Capacitance Force Microscopy, ***K. Kimura,*** *K. Kobayashi, H. Yamada,* Kyoto University, Japan*; K. Usuda,* Toshiba Corporation, Japan*; K. Matsushige,* Kyoto University, Japan

We have recently developed a novel scanning probe technique, scanning capacitance force microscopy (SCFM) capable of measuring two-dimensional (2D) dopant profiling of semiconducting sample. SCFM, of which operating principle is based on the detection of an electric force between the conducting tip and sample, does@aa n@t utilize ultrahigh frequency capacitance sensor required for conventional scanning capacitance microscopy (SCM). In SCFM, an electric field alternating at an angular frequency @omega@ is applied between the tip and the semiconducting sample and then the induced electric force (ESF) oscillating at its third harmonic frequency (3@omega@) is detected using a lock-in amplifier as an SCFM signal. This is because the magnitude of the induced ESF is proportional to the square of the applied electric field and the capacitance of the semiconducting sample, which is also modulated at @omega@. Thus the amplitude-and-phase (Acos @phi@) signal of the induced ESF alternating at 3@omega@ contains information on the differential capacitance (dC/dV). We performed cross-sectional SCFM imaging of a n-channel metal-oxide-semiconductor field effect transistor (n-MOSFET). In source and drain regions, dopant density decreases from 10@super 21@ cm@super -3@ at the surface to 10@super 17@ cm@super -3@ at about 100 nm in the depth direction. Channel length is 500 nm and dopant density in channel region is 10@super 17@ cm@super -3@. We observed a drastic change in SCFM signal at about 100 nm in the depth direction of the source or drain regions. We also observed a characteristic contrast at the depleted area under the gate oxide corresponding to the channel region. In the presentation, we present SCFM images on MOSFETs obtained both in contact mode and dynamic mode. We discuss the interpretation of the obtained contrast and its dependence on the applied DC voltage. We also compare those SCFM images with SCM images and SIMS profiles.

SC+EM-WeP4 Effect of Mn Composition on Characterization of Zn@sub 1-x@Mn@sub x@Se Epilayers, ***Y.-D. Choi,*** *Y.-M. Yu, D.-J. Kim, K.-J. Lee,* Mokwon University, South Korea*; Byungsung O, K.-S. Lee,* Chungnam National University, South Korea*; I.-H. Choi,* Chung-Ang University, South Korea*; M.-Y. Yoon,* Joongbu University, South Korea

ZnMnSe is one of II-VI diluted magnetic semiconductors, in which the cations of the host crystal are replaced with Mn@super 2+@ ions. Recently, ZnMnSe is used as a material to inject spin inside the quantum structures. The crystal structure of the bulk ZnMnSe is cubic in the range of the Mn composition for x0.05. The absorption and PL spectra at 10 K were compared. In the region of small range x, the band gap energy showed weak bowing effect. It was found that PL peak near the energy band gap was related to the free exciton from the absorption measurements. From Raman measurement at the room temperature, ZnSe-like LO phonon peak was observed, and with the increasing Mn composition x the blue shift of 3.5 cm@super -1@ was observed. The variation of the dielectric constants @epsilon@@sub 1@ and @epsilon@@sub 2@ as a function of Mn composition x by SE was measured. When x is small, it was found that the predominant transition took place in the critical point(CP) of each band structure, and with the increasing x, CP was shifted to low energy side.

SC+EM-WeP5 Linear Magnetoresistance in LaSb@sub 2@: The Role of Charge-Density Waves@footnote *@, *A. Acatrinei,* Louisiana State University*; J.W. Richardson,* Argonne National Laboratory*; D. Young, D. Browne, Y. Losovyj, P.T. Sprunger,* ***R.L. Kurtz,*** Louisiana State University

LaSb@sub 2@ exhibits a giant linear magnetoresistance@footnote 1@ to very high fields (40T) yet it is composed of non-magnetic elements. This work reports on the role of charge-density waves (CDW) in providing a magnetic response within the two-dimensional constraints of this layered compound. Single-crystals of LaSb@sub 2@ were grown in an excess Sb flux using high-purity La and Sb and X-ray diffraction measurements confirm that it has an orthorhombic crystal-structure with a=6.38 b=6.23 and c=18.75Å. The layered structure of Sb planes separated by bi-layers of La-Sb chains gives the material a micacious appearance. X-ray measurements suggest a mosaic spread of ~0.5-1° and it is likely that the material is highly twinned. When the material is cleaved in uhv, STM studies give flat terraces mostly separated by the unit cell height and, occasionally, we observe half-unit cell steps. Neutron diffraction measurements show temperature-dependent peaks that are not from the orthorhombic structure but have been attributed to the CDWs. Further clues to the potential origin of charge-density waves come from a comparison of photoemission and density-functional studies. Photoemission studies show that the electronic structure is highly two-dimensional. Density functional theory predicts nearly square tube-like Fermi surfaces that extend along the c direction and provide the opportunity for a high degree of nesting within the basal plane. It is this nesting that provides an electronic mechanism to couple charge density oscillations to the electronic structure. A high-resolution study of the CDW gap opening at FS will be presented and discussed in terms of the role of CDWs in the magnetic response. @FootnoteText@@footnote *@We would like to acknowledge Argonne's IPNS, the LSU CAMD synchrotron light source, and the NSF for their support of this work. @footnote 1@ Bud'ko, Canfield, Mielke, et al., Phys. Rev. B 57, 13624 (1998).

SC+EM-WeP6 Ferromagnetic Co-Implanted Rutile TiO@sub 2@(110) for Spintronics Applications, ***V. Shutthanandan,*** *S. Thevuthasan, T. Droubay, S.M. Heald, M.H. Englehard, L.V. Saraf, S.A. Chambers,* Pacific Northwest National Laboratory*; B.S. Mun,* Lawrence Berkeley National Laboratory*; R.P. Sears, B. Taylor, B.S. Sinkovic,* University of Connecticut

There is a growing interest in diluted magnetic semiconductor materials due to their potential applications in spintronics area. The ability to efficiently inject spins into multi-layer semiconductor device structures for room temperature operations creates new and exciting possibilities for utilizing DMS materials in semiconductor applications. Some of the dilute magnetic semiconductors with the potential for room temperature spintronics applications include Co-doped ZnO, Mn-doped GaN and Co-doped TiO@sub 2@. Although there are still some issues associated with the growth of single crystal Co-doped anatase TiO@sub 2@, recent experiments show that this material is the most promising candidate because of its room temperature ferromagnetism.@footnote 1,2@ Recently, we have investigated the Co doping in rutile TiO@sub 2@ using ion implantation as a function of implantation temperature and subsequent annealing. Co implantation at room temperature shows that the implanted Co stays as mostly Co metal in TiO@sub 2@(110). Subsequent annealing around 875 K in air promotes Co diffusion towards the surface. During this process Co gets oxidized in the near surface region. Although a portion of the implanted Co appears to be oxidized as a function of implantation temperature up to 875 K, the Co implantation at 1075 K indicates that the implanted Co is mostly oxidized. Some of the implanted Co at 1075 K appears to be substituting for Ti. These samples were characterized using several surface and bulk sensitive techniques including x-ray photoelectron spectroscopy (XPS), Co K and L edge x-ray absorption near edge structure (XANES), and Rutherford backscattering spectrometry (RBS)/channeling. These results with the room temperature vibrating sample magnetometer (VSM) and magneto-optical Kerr effect (MOKE) measurements from these samples will be discussed. @FootnoteText@@footnote 1@ M. Matsumoto et al., Science, 291, (2001) 854.@footnote 2@ S.A. Chambers et al., Appl. Phys. Lett. 79 (2001) 3467.

SC+EM-WeP7 The Crystallization Behavior and Interfacial Reaction between GeTe and Sb@sub 2@Te@sub 3@ Film for the Application to the Phase Change Memory, ***E.J. Jung,*** *S.K. Kang, B.G. Min,* Yonsei University, South Korea*; H. Horii, Y.H. Ha, J.H. Park,* Samsung, South Korea*; D.H. Ko,* Yonsei University, South Korea

Flash memory has been widely used as a non-volatile memory, however, it has limitations, such as low speed and low write endurance. To supplement

the limitation of flash memory, recently phase change memory(PCM) has been investigated using the class of elements known as chalcogenide. This technology is expected to allow chips that have SRAM speed, DRAM cost and FLASH power characteristic and non-volatility. Chalcogenide is a confirmed phase change material used in re-writeable CDs and DVDs. This material changes phases reversibly and quickly between an amorphous state with high resistivity and a crystalline state with low resistivity. Previously, GeSbTe system has been known as pseudobinary GeTe and Sb@sub 2@Te@sub 3@ alloys with different combinations, such as Ge@sub 2@Sb@sub 2@Te@sub 5@, Ge@sub 1@Sb@sub 2@Te@sub 4@, and Ge@sub 1@Sb@sub 4@Te@sub 7@. Recently GeTe-Sb@sub 2@Te@sub 3@ multi-layer structure is studied to improve crystallization time and rewrite cycle time in optical data storage. We investigated interface reaction and crystallization property between GeTe and Sb@sub 2@Te@sub 3@ thin film to observe a created composition at interface in variable annealing temperature and methods. The GeTe-Sb@sub 2@Te@sub 3@ film was deposited on SiO@sub 2@ by D.C. magnetron sputtering method with GeTe and Sb@sub 2@Te@sub 3@ alloy target. The thickness of each layer is 10nm. After the deposition of GeTe-Sb@sub 2@Te@sub 3@ film, TiN was deposited in a same chamber without breaking vacuum as a capping layer. Sample was annealed at temperature between 200°C and 700°C using furnace and RTP. To study crystallization behavior, XRD analysis were performed. In addition, the sheet resistance was measured by using 4-point probe. TEM analysis was performed to investigate interface reaction between GeTe and Sb@sub 2@Te@sub 3@ thin film. And to observe distribution of each element atom in interface reaction, AES depth profile and EDX were carried out.

SC+EM-WeP8 The Dependence of Charge Collection Efficiency on Metal Electrode in Polycrystalline CdZnTe(x=0.04) Material, ***S.Y. Ahn,*** *K.H. Kim,* Korea University*; S.Y. An,* Korea Institute of Science and Technology*; J.K. Hong, K.N. Oh,* Korea University*; S.U. Kim,* Korea University, Korea

There is currently a growing interests on digital X-ray imagers. A direct methods that has several benefits over the indirect methods like convenient image acquistion, storage and transmission, digital image processing, computer-assisted diagosis, real time images, a better spatial resolution dose for equivalent images.@footnote 1@ To generate appropriate e-h pair in CdZnTe film on incident X-ray, thick CdZnTe film was required. Using thermal evaporation method that is generally adquate to deposit thick films, CdZnTe thick films was obtained having ~100 µm in thickness. We investigate the contact between CdZnTe thick film and a variety of metals with the aim of determining whether the choice of metal can improve the performance of X-ray imager detectors, in particular minimizing the dark current. The sample consist of 100 µm thick CdZnTe(x=0.04) with top electrodes formed from Au, In.@footnote 2@ The detection capability of the material has been demonstrated by time-of-flight(TOF) measurements performed on a device made by an n-CdZnTe epilayer. The analysis of the TOF collected charge as a function of the applied voltage give µ @tau@ ~ 10 @super -4@ cm@super 2@/V for this material.@footnote 3@ And we measured resistivity using four-point probe method. CdZnTe(x=0.04) thick film's resistivity is 3 x 10 @super 9@ @ohm@ cm. Au deposited sample is founded to have better properties than others in many respects such as low leakage current, chemicalstability. @FootnoteText@ @footnote 1@ Y. Eisen, A. Shor, J. Crystal Groeth 184/185 (1998) 1302.@footnote 2@ M. J. Mescher, J. F. Hoburg, T. E. Schlesinger, R. B. James IEEE Transactions on Nuclear Science, Vol. 46, NO. 6, December. (1999)@footnote 3@ X. J. Bao, T. E. Schlesinger, R. B. James, Semiconductors for room temperature nuclear detector applications, in: T.E. Schlesinger, R.B. James (Eds.), Semicounductors and Semimetals, Vol. 43, Academic Press, San Diego. (1995).

SC+EM-WeP9 Surface Passivation of HgCdTe by RF Sputtered Silicon Nitride, ***S.Y An,*** Korea University*; Y.C. Joung,* Hanyang University, Korea*; S.H Lee,* Korea University*; S.H. Suh,* Korea Institute of Science and Technology*; J.S Kim,* Korea Institute of Science and Technology, Korea

There have been considerable advances in HgCdTe device technology. However, surface passivation and insulator/HgCdTe interface are still a subject of great interests.@footnote 1@ Up to now, there has been a lot of results reported on passivants for HgCdTe devices. Recently, silicon nitride (SiN@sub x@) deposited by ECR-PCVD has been reported as a passivant for HgCdTe.@footnote 1,2@ But, there was no research report on RF magnetron sputtered SiN@sub x@ for HgCdTe passivation. In this paper we briefly report some experimental results concerning about interface state and fixed charge density in metal-insulator-semiconductor (MIS) structures realized by RF magnetron sputtered SiN@sub x@ on HgCdTe surface. The electrical properties of MIS structure were studied as a function of sputtering power and working pressure of sputtering chamber. Capacitance-voltage (C-V) characteristics were measured at 1MHz and interface state densities were obtained by Terman's method. It was observed that conductivity type of HgCdTe is closely related with deposition rate of SiNx. The p-type conductivity of HgCdTe was converted to n-type conductivity at deposition rate of less than 25Å/min. To prevent p-type HgCdTe from type conversion, it is necessary to maintain high sputtering rate of SiNx at initial stage. The interface state density and fixed charge density of SiN@sub x@ film on HgCdTe were 1.9x10@super 10@cm@super -2@, and 1.5x10@super 11@cm@super -2@, respectively, at sputtering power of 175W. @FootnoteText@@footnote 1@O. P. Agnihotri, C. A. Musca and L. Faraone, Semicond. Sci. Technol. Vol. 13. 839 (1998). @footnote 2@Y. Nemirovsky and G. Bahir, J. Vac. Sci. Technol. A, Vol.7, No. 2, 450 (1989).@Footnote 3@G. Sudo, N. Kajihara, Y. Miyamoto and K. Tanikawa, Appl. Phys. Lett. Vol.51, No.19, 1521 (1987).

SC+EM-WeP10 Growth and Characterization of Thin Films of a New Semiconductor produced by Co-Sputtering of CdTe and Al@footnote 1@, ***M. Melendez-Lira,*** Cinvestav-IPN, Mexico*; M. Zapata-Torres,* CICATA-IPN, Mexico*; S. Jimenez-Sandoval,* Cinvestav-IPN, Mexico*; M.A. Fuentes-Cabrera,* Carnegie Mellon University

The atomic elements Cd, Te and Al form the compunds CdTe, CdAl@sub 2@Te@sub 4@ and Al@sub 2@Te@sub 3@. CdTe and CdAl@sub 2@Te@sub 4@ are semiconductors and their room temperature band gap are 1.5 eV and 2.0 eV, respectively. The existence of these compounds prompted us to produce a new alloy based in CdTe and Al. We have produced thin films of Cd@sub x@TeAl@sub 1-x@ by rf co-sputtering employing targets of CdTe and Al under an argon atmosphere. Aluminum content in the films was controlled by the rf power applied to the aluminum target. The chemical, structural and optical properties of the thin films have been studied by EDS, X ray diffraction, AFM, optical transmission, photoreflectance, photoluminescence and Raman spectroscopies. EDS, X-ray diffraction and Raman results shown clearly that aluminum has been incorporated in the CdTe lattice, for low aluminum content an hexagonal structure is found. For low aluminum contents transmission spectroscopy results indicate a clear blue shift in the band gap of the alloy. Photoreflectance spectroscopy indicates the presence of a direct band gap of 1.6 eV; for an aluminum content of 6%. Band gap values are discussed taking in account theoretical results obtained by first principles employing the Local Density Approximation and Generalized-Density Functional Theory approaches. @FootnoteText@ @footnote 1@Work partially supported by CONACyT-Mexico.

SC+EM-WeP11 Current Mapping of GaN Films, *A.A. Pomarico,* University of Lecce, Italy*; **J.C. Dickinson,*** Virginia Commonwealth University*; R. Cingolani,* University of Lecce, Italy*; H. Morkoc, A.A. Baski,* Virginia Commonwealth University

GaN-based devices have made remarkable advances recently, but still suffer from excessive current leakage, due in part to extended defects in the material and point defects which are not well understood. We have used the technique of conductive atomic force microscopy (C-AFM) to investigate how the local conductivity of GaN films is related to morphology.@footnote 1@ Our studies indicate enhanced conductivity for prismatic planes found around islands on as-grown samples, and on the edges of pits formed by post-growth chemical etching. In the case of etched HVPE samples, AFM images show hexagonal pits produced by the etching of defect sites on c-plane GaN. Simultaneous C-AFM images show detectable current only at the edges of such pits for forward-bias voltages below 4 V. This indicates that crystallographic planes tilted with respect to the c-plane have a significantly higher conductivity than surrounding areas. Although still under investigation, possible mechanisms for this enhanced electrical activity include extended defects, surface states, and modified Schottky barrier heights on prismatic planes. @FootnoteText@@footnote 1@ A.A. Pomarico et al., Appl. Phys. Lett. 82, 1890 (2003).

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