Photonics
Room Exhibit Hall C & D - Session PH-TuP
Poster Session

PH-TuP1 Optical Processes in PMMA, SiO@sub 2@ and Hybrid Organic-Inorganic Sol-Gel Films Colored with Rhodamines, ***J.J. Pérez-Bueno***, *S.R. Vazquez-García,* Universidad Autónoma de Querétaro, México*; L. García-González,* Unidad Querétaro, México*; Yu.V. Vorobiev, J. González-Hernández,* Unidad Querétaro, México, Mexico

Various types of rhodamines (B-500, 6GDN), at different concentration, have been introduced in thin layers formed by a single matrix (SiO@sub 2@ or PMMA) and by a hybrid matrix, that is, a mixture of SiO@sub 2@ and an acrylic polymer, at variuos proportions. Firts, the precursor acrylic polymer was synthesized using the following components: 2-hydroxyethyl methacrylate (37.3 %), butyl acrylate (36.3 %), styreno (20.0 %), methyl methacrylate (4.4 %) and isobutyl methacrylate (2.0 %). Before solidification, the precursor avrylic polymer was dissolved in a mixture of 2-propanol and 2-butoxyethanol and then the tetraethyl-orthosilicate (TEOS) added to that solution. The hydrolisation and polycondensation were catalyzed using HCl. The optical absorption and the photoluminescence of layers on glass substrates were measured. It is found that the spectral position and fine structure of rhodamine absorption band greatly depend on the type of matrix. The luminescence intensity in layers with the PMMA and hybrid matrix is more intense than that of the layers with the SiO@sub 2@ matrix. The effects produced by the aggregation of the rhodamin molecules and their local environment on the optical processes addressed above are discussed.

PH-TuP2 Band Gap Modulation from 0.5 eV to 1.5 eV Employing the Alloy (CdTe)@sub x@(In@sub 2@Te@sub 3@)@sub 1-x@@footnote 1@, ***M. Meléndez-Lira***, CINVESTAV-IPN, México*; M. Zapata-Torres,* CICATA-IPN, México*; R. Castro-Rodríguez,* CINVESTAV-IPN, México

CdTe is a semiconductor with a wide range of applications and alloyed with S, Zn, or Se allows high energy band gap modulation. To increase the range of band gap modulation in the near infrared employing CdTe alloys is a very interesting possibility with potential applications in the optoelectronic industry. We produced thin films of the alloy (CdTe)@sub x@(In@sub 2@Te@sub 3@)@sub 1-x@ employing the close spaced vapor transport technique combined with free evaporation. As sources we employed CdTe and In@sub 2@Te@sub 3@ powders. Composition was controlled by the temperature of sources and substrate. Structural characterization was carried out employing X-ray diffraction, scanning electron microscopy and atomic force microscopy. Chemical composition was determined by energy dispersive X-ray analysis. Room temperature transmission and photoreflectance spectroscopies were employed for optical characterization. The results shown that for single phase samples a sharp transition band edge in the transmission spectrum is obtained. From it a potential band gap modulation in the range from 0.5 eV to 1.5 eV is clearly observed. Photoreflectance results clearly showed that the band edge is of the direct type. The feasibility of the alloy is discussed taking in account the higher solubility of CdTe in In@sub 2@Te@sub 3@ because of its ordered vacancy structure. The band gap change is correlated with the indium content in the samples. @FootnoteText@@footnote 1@ Work partially supported by CONACyT.

PH-TuP3 Waveguiding in Microchip Lasers, ***N.J. van Druten***, Leiden University and Delft Technical University, The Netherlands*; S.S.R. Oemrawsingh, Y. Lien, C. Serrat, M.P. van Exter, J.P. Woerdman,* Leiden University, The Netherlands

Microchip lasers@footnote 1@ typically consist of a thin, rare-earth-doped laser crystal, dielectrically coated on both surfaces to form a complete optical cavity. They are small and can be manufactured cheaply, because only a small amount of material is needed. Transverse-mode formation in microchip lasers is of considerable complexity, because it is the result of several competing waveguiding mechanisms, such as (i) the weak curvature of the mirrors, (ii) thermal lensing, and (iii) gain guiding (including gain-related index-guiding). The latter two depend critically on the material properties of the laser crystal. We have made a careful experimental and theoretical@footnote 2@ study of the transverse-mode formation in microchip lasers, in particular combining (i) and (iii), and concentrating on the regime where these two guiding effects have similar strength. The experiments were performed on a Nd:YVO@sub 4@ microchip laser with a plano-concave cavity configuration, longitudinally pumped by a transversely Gaussian pump beam derived from a titanium:sapphire laser. A surprisingly varied collection of mode profiles was found, deviating significantly from the standard Laguerre-Gaussian modes that are usually found for such cylindrically symmetric cases. In addition, the far-field profiles were generally found to be considerably different from the near-field profiles. We have also found cases where the far-field pattern has a minimum on axis (i.e., conical emission), while the near-field profile has an on-axis maximum. The agreement between theory and experiment is excellent, in particular when one considers the large variations in the observed mode profiles and the relative simplicity of our theoretical model. @FootnoteText@ @footnote 1@ J. J. Zayhowski and A. Mooradian, Opt. Lett. 14, 24 (1989). @footnote 2@ C. Serrat, M. P. van Exter, N. J. van Druten, and J. P. Woerdman, IEEE J. Quant. Electron. 35, 1314 (1999).

PH-TuP4 Integrated Optoelectronic Sensor Based on GaN, ***D. Starikov***, *E. Kim, C. Boney, J.-W. Um, I. Hernandez, N. Medelci, A. Bensaoula,* University of Houston

An integrated optoelectronic sensor based on GaN grown on sapphire by RF-assisted MBE is presented. The sensor combines inter-digitated line arrays of light emitting diodes (LEDs) and photodiodes based on Schottky barriers and fabricated in a single technological process. Under reverse bias the LEDs exhibit broad-spectrum avalanche emission with a strong band in the range from 365 to 475 nm. At forward bias the LED emission is more intense and forms a band from 400 to 600 nm. The photodiodes are sensitive in a spectral range from at least 250 to 400 nm. In the absorption/reflection mode the sensor operation is based on the spectral match between the avalanche emission and the photodiode sensitivity in the range from 365 to 400 nm. Using this set up, Acridine concentration measurements in aqueous solutions were performed using the absorption band of 300-450 nm. The fluorescence measurements were based on detection of the delayed fluorescence emission measured from alcohol solutions of Fluoran dye in the range from 290 to 320 nm under excitation with short optical pulses from the LEDs. The working range and the sensitivity of the sensor were evaluated using preset calibrated concentrations and will be presented during the presentation. This work was funded by Institute of Space Systems and Operations, NASA, and Texas ATP. The material is based in part upon work supported by the Texas Space Grant Consortium.

PH-TuP5 Fabrication and Optical Properties of Ordered Nanoscale Silicon Structures, ***A. Wellner***, *R. Neuendorf, R.E. Palmer,* The University of Birmingham, UK

Reactive ion etching (RIE) of Silicon wafers using predeposited metal clusters (Ag, Au, Ni) as nanoscale etch masks yields Silicon nanopillars with extremely high aspect ratios @footnote 1,2@ The size of the individual pillars, their separation and their arrangement is mainly determined by the method used for cluster deposition. The cluster deposition can be varied between the two extreme conditions of i) random cluster deposition, resulting in randomly arranged pillars of lateral dimensions reflecting the cluster size distribution or ii) deposition of size selected clusters through a template consisting of a self-assembled monolayer of nanometer-sized polymer balls, resulting in well ordered arrays of nearly equal size pillars. In this work we investigate the structural and optical properties of ordered and dis-ordered 2D arrangements of Silicon pillars through a combination of Scanning Electron Microscopy (SEM) with optical spectroscopy methods such as absorption/ reflection spectroscopy and photoluminescence spectroscopy (PL). Ordered pillar arrays show evidence of a developing photonic band gap in good agreement with theoretical predictions using the generalized Mie theory (GMT), while systems with pillar diameters (15nm exhibit exciton features characteristic of quantum confinement. @FootnoteText@@footnote 1@K. Seeger and R. E. Palmer, Appl. Phys. Lett. 74, 1627 (1999) @footnote 2@K. Seeger and R. E. Palmer, J. Phys. D 32, L129 (1999).

PH-TuP6 Etching of Optical Coating Oxides in Fluorine and Chlorine Plasmas, ***W.B. Song***, *W. Liu, J.J. Talghader,* University of Minnesota

With the increasing use of micro-optical components in optoelectronics and MEMS, it is becoming increasingly important to understand the behavior of traditional optical materials in the microfabrication environment. For this purpose, we studied the etching of optical coating oxides in a variety of fluorine and chlorine plasmas. The oxides used in this study are Al@sub 2@O@sub 3@, HfO@sub 2@, Nb@sub 2@O@sub 5@, SiO@sub 2@, Ta@sub 2@O@sub 5@, TiO@sub 2@, Y@sub 2@O@sub 3@, and ZrO@sub 2@. These coatings are transparent from the near IR to UV and have a broad range of refractive indices. Using the well-known etching chemistry of SiO@sub 2@ as a guide, we attempt to correlate the

volatility of the etch products of these oxides to the observed etching behavior in CF@sub 4@, SF@sub 6@, Cl@sub 2@, and their derivatives such as CF@sub 4@+O@sub 2@, etc. The results show that the volatility predicts general etch reactions with good accuracy, but is less successful in predicting relative etch rates. For example, our results show that Nb@sub 2@O@sub 5@, Ta@sub 2@O@sub 5@, TiO@sub 2@ and SiO@sub 2@ are etched in fluorine plasmas, while Al@sub 2@O@sub 3@, HfO@sub 2@, Y@sub 2@O@sub 3@, and ZrO@sub 2@ are not. All of the etched oxides have fluorine compounds with melting or sublimating temperatures less than 300°C. Increasing the substrate temperature to 340°C does not affect the behavior of the unattacked oxides. In chlorine plasmas, all of the oxides show some nonzero etch rate, which also matches with published volatility data. Finally, we present the selectivity of the oxides based on the obtained results.

PH-TuP7 Study of the GaAs etching with the Electron Cyclotron Resonance Source Plasmas, ***P. Kumar***, *S.K. Angra, L.M. Bharadwaj, R.P. Bajpai,* Central Scientific Instruments Organisation, India

The III-V materials are precisely used for the fabrication of the Optoelectonics devices as LEDs, laser diodes and high speed electronics devices. The devices fabrication process in the line is mainly used 13.56 MHz RIE system with the different gases combinations such as BCl@sub3@,Cl@sub2@ , hydro carbon and further activated them using the Ar ions into it. The reactive ion beam etching combined with the Electron Cyclotron Resonance discharge plasma (ECR-RIBE) and chemically assisted ECR plasma etching is especially useful , because of its highly directional and causes low damage. In this article, we had investigated the of GaAs etching using the Electron Cyclotron Resonance Cl@sub2@ plasma operated at 2.45 GHZ. Also the first time the Chemically assisted ECR plasma etching of the GaAs was investigated with the combination of the Ar/I@sub2@. The optimization of the system for the etching of GaAs was carried out with the numerous different parameters such as flow rates of the gases such as chlorine and added up Ar into cholrine, bias to the stage or substrate in the range of 15to 100 volt dc bias, partial pressure ranging from 0.1 mTorr to 1 mTorr of the process chamber, variation of the space between stage to the exit windows of the plasma source and measurements of uniformity of process over the 2 to 6 inches were studies. The Argon plasma is exposed to the substrate while Iodine is directly implemented to the substrate for the chemically assisted process. The results are qualitatively put into accordance with the observed reactive species of the plasma using the optical emission spectroscopy and also with the total plasma density calculated using Langmuir probe measurements of the plasmas. The etching uniformity of the substrate of 2, 3, 4 and 6 inches was performed and that is matched with the plasma ion density uniformity measurements and attempts were put forward to improve the uniformity by further confinement of the plasma using the magnetic field and also putting the biasing to the substrate.

PH-TuP8 Effect of Dry Etching Conditions on Surface Morphology and Optical Properties of GaN Films in Chlorine-Based Inductively Coupled Plasmas, ***Y.B. Hahn,*** Chonbuk National University, South Korea*; B.-C. Cho,* LG Precision Co., Ltd.*; Y.-H. Im,* Chonbuk National University, South Korea

A parametric study on dry etching of undoped, n- and p-type GaN films has been carried out in a planar type inductively coupled plasma (ICP) system. The effect of etching conditions on surface chemistry, morphology, and optical properties of GaN Films etched in Cl2/Ar discharges was studied in detail using atomic force microscopy (AFM), scanning electron microscope (SEM), and photoluminescence (PL) measurement. The GaN films showed overall similar etching characteristics. Although the surface roughness was dependent on plasma parameters, it was a strong function of dc bias voltage. The surface roughness was relatively independent of the rf power up to 150 W, resulting quite smooth morphology (rms roughness 1.1 - 1.3 nm), while etching at higher chuck powers (> 200 W) produced rougher surface due to increased ion bombardment. Stoichiometry at the etched surface of undoped and p-type GaN films was maintained, indicating equirate removal of component. By contrast n-GaN showed some depletion of nitrogen from the surface. The lattice disorder and point defects were much less generated during the ICP etching than reactive ion etching (RIE). The PL peak of etched p-GaN was somewhat red-shifted from 366 nm to 460 nm, but it showed a strong peak intensity after ICP etching, which was very similar to the result obtained after thermal annealing of as-grown p-GaN films.

PH-TuP9 Plasma Etching Research in Integrated Photonics, ***K.H.A. Bogart***, *M.A. Cappuzzo, L.T. Gomez, J.F. Bailey, R.W. Long,* Bell Laboratories, Lucent Technologies

The skyrocketing consumer demand for greater Internet access, telecommunications, and other broadband services has accelerated the need for advanced lightwave transmission capacity such as wavelength division multiplexing (WDM). WDM transport is evolving into dynamic WDM systems requiring several optical components including sources, waveguide grating routers, reconfigurable add/drops, optical amplifiers, and optical cross connects. Integration of these components is vital for decreasing fiber insertion losses and for low cost manufacturing and packaging. Silicon optical bench (SiOB) technology leverages off the mature silicon integrated circuit (IC) industry by utilizing photolithography, thin film deposition and etching techniques to create complex planar optical devices on the silicon platform. In contrast to IC's, SiOB devices are several micrometers to centimeters in length and use optical quality materials, thus producing diverse challenges in materials processing. Plasma etching of planar waveguide devices such as waveguide routers, amplifiers, optical compensators, and switches will be examined with a focus on newer high-delta optical materials such as Ge- or Ti-doped silica (delta = refractive index difference between the waveguide core and the surrounding cladding), aluminosilicates, and ferroelectric materials. Comparisons of photoresist and hardmask materials such as poly-silicon and aluminum oxide will be made. Potential solutions to integration issues with the high-delta materials will also be presented.

Author Index

Bold page numbers indicate presenter