Wednesday Morning, November 4, 1998

Selected Energy Epitaxy Topical Conference
Room 327 - Session SE-WeM

Selected Energy Epitaxial Growth Processes
Moderator: R. Brandt

8:20am **SE-WeM1 Ab Initio Studies of the Surfaces and Growth of GaN and AlN**, ***W.A. Goddard III***, *R.P. Muller, B.L. Tsai,* California Institute of Technology **INVITED**

We have examined the reconstruction and growth of cubic GaN and AlN using Density Functional Theory with Generalized Gradient Approximations. We find stable surfaces for excess metal lead to a c(2x2) structure while stoichiometric leads to metal termination but a P(2x2) structure. Implications for growth will be discussed.

9:00am **SE-WeM3 Film Defects and Growth Dynamics in Wide Bandgap Epitaxy**, ***F.A. Ponce***, Xerox Palo Alto Research Center **INVITED**

The III-V nitride semiconductors have achieved a high degree of notoriety in the last few years.@footnote 1@ Light emitting devices based on double heterostructure InGaN/GaN films have been produced with light emission efficiencies exceeding incandescent lighting. Blue diode lasers with continuous operation for more than 10,000 hours using AlGaN/GaN/InGaN heterostructures have been reported and their commercial use is expected in the near future. The high optoelectronic performance of nitride semiconductors is related to an interesting microstructure, quite different from other semiconductors. Large dislocation densities are observed (~10@super 10@ cm@super -2@) and are associated with a columnar array of defect-free crystallites. The defect structure appears to play a key role in the relaxation of thermal stresses, typical in these materials, allowing the local growth of high quality heterostructures under otherwise unfavorable conditions. The nature of the substrate/thin film interfaces will be discussed, as well as the role of the buffer layer. Details of the dislocation arrangement and structure and correlation with light emitting properties will be presented for GaN thin films and for InGaN quantum wells. @FootnoteText@ @footnote 1@ F. A. Ponce and D. P. Bour, Nature Vol. 386, 351 (1997).

9:40am **SE-WeM5 Growth of Thin Film Materials with Supersonic Molecular Beams**, ***W. Ho***, Cornell University **INVITED**

Atomic and molecular beams have been used extensively to probe fundamental physical and chemical properties of atoms and molecules. A new application of molecular beams for materials synthesis is emerging. The unique properties of supersonic molecular beams which make this new application to thin film growth promising are described. Problems encountered in the implementation of supersonic jet epitaxy (SJE) as well as growth conditions favorable for the incorporation of real-time, in situ monitoring are discussed. The advantages and disadvantages of different precursors for the growth of cubic-SiC on Si are compared. The growth rate and morphology of the grown films are shown to depend on the kinetic energy of the precursors and the growth temperature. Enhancing the kinetic energy of precursors also led to lower growth temperatures for single crystal GaN and AlN thin films on silicon based substrates. Problems which remain to be solved in SJE of wide band gap semiconductors are summarized.

10:20am **SE-WeM7 Selected Energy Etching of Semiconductors by Electron-enhanced Surface Reactions**, ***H.P. Gillis***, *M.J. Christopher,* University of California, Los Angeles*; K.P. Martin, D.A. Choutov*,* Georgia Tech **INVITED**

It is well established that the standard ion-enhanced dry etching methods (RIE, ECR, and CAIBE) can damage the sample during etching by momentum transfer from energetic ions. The result is degradation of optical, electrical, and morphological properties of etched surfaces. We will review these energy-dependent damage mechanisms from ion-enhanced etching, and present results from an alternative approach--Low Energy Electron Enhanced Etching (LE4)--that avoids ion bombardment altogether. LE4 gives mirror smooth surfaces (RMS surface roughness 2 - 3 Angstroms) and maintains stoichiometry in compound semiconductors while giving highly anisotropic pattern transfer in micrometer and nanometer scale structures in Si, GaAs, and GaN. Special emphasis will be placed on the role of electron energy thresholds in developing selective processes and in controlling the polishing or "smoothening" of the surface during etching. @FootnoteText@ *Present address: National Semiconductors, San Jose, CA.

11:40am **SE-WeM11 Velocity, Temperature, and Chemical Composition of a dc-Arcjet Plume**, ***J.B. Jeffries***, *J. Luque, W. Juchmann,* SRI International

Laser-induced fluorescence, optical emission, and Langmuir probe measurements are used to characterize the reactive plume of a dc-arcjet reactor during diamond deposition. We find one third of the feedstock hydrogen is dissociated into atoms. Optical measurements are used to determine spatially resolved gas temperature, plume velocity, and the spatial variation of the concentrations of reactive intermediates. The atomic hydrogen concentration is not in equilibrium with the gas temperature, and finite rate chemistry controls the concentrations of the reactive intermediate species in the plume. The supersonic directed velocity of the plume produces a shock structure just above the substrate. The temperature and pressure gradient produced by this shock influences the chemical composition of the gases in the boundary layer and the transport of reactants to the surface. Supported by ARO and DARPA via the NRL.

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