Thursday Morning, November 5, 1998

Thin Films Division
Room 310 - Session TF-ThM
Thin Films for Flat Panel Applications

Moderator: G.N. Parsons, North Carolina State University

8:20am **TF-ThM1 New Dry Etch Applications for Amorphous TFTs in Flat Panel Displays(FPD)***, **W.W. Yao,*** dpiX; A Xerox New Enterprise Company **INVITED**

Key goals driving FPD process development are: 1. large panel size; 2. Low cost; 3. Low power consumption. Recent introduction of new process technologies especially in the dry etch area are key enablers for new display architecture. Increase in display size with longer gate and data lines is driving the switch to aluminum metal with its lower resistivity to reduce the RC time delay. Hillock free Aluminum gate metal is enabled by tapered Al dry etching and high rate PECVD process with short time-temeprature cycle. Cost reduction has focused on productivity improvement but new 3rd generataion tools has renewed interest recently in reduced mask count display architecture. ITO pixel is etched using very strong acids and dictates its placement in the process architecture. New ITO dry etch removes process constraints and allows placement of the ITO on top of the passivation dielectric. Power consumption is dominated by backlight intensity and can be reduced by higher aperture ratio pixel design. The ITO pixel dimension is increased if the TFT size and its assoicated coupling capacitance is shrinked through the use of selective n+ etch in intrinsic silicon.

9:00am **TF-ThM3 Field Emission and Photo Emission from Si Micro Tip Arrays Coated with Bias-Grown Diamond Films***, **M.Q. Ding,** A.R. Krauss,* Argonne National Laboratory*; O. Auciello,* Argonne National Laboratory, U. S. A.*; D.M. Gruen, T.D. Corrigan,* Argonne National Laboratory*; M.E. Kordesch,* Ohio University*; D. Temple, D. Palmer, G.E. McGuire,* MCNC

A considerable improvement in the properties of field and photoelectron emission from ungated Si micro tip arrays coated with bias-grown diamond thin films is reported. Prior to loading into a MPCVD reactor (ASTeX PDS-17), the microtip arrays were ultrasonically treated in a 0.1 µmm diamond suspension. Diamond films were grown in a CH@sub 4@-H@sub 2@-N@sub 2@ plasma at a substrate temperature of 800 °C and a negative bias of -150 V. The film had a complete coverage over the tip arrays as observed from secondary electron microscopy (SEM). Electron emission characteristics were measured in two different systems: field emission current-field (IF) measuring apparatus and photoelectron emission microscopy (PEEM). IF measurements showed a very low turn-on electric field with a threshold fields of 1.5 V/µmm (vs 40 V/µmm for uncoated tip arrays), and a current density of 1 mA/cm2 at around 4 V/µmm. In the PEEM studies, UV light from a mercury arc lamp was used to excite photoelectrons. While the lamp was on, the PEEM revealed a uniform and bright photoelectron emission image of the coated tip arrays in contrast to that of the uncoated arrays. When the lamp was off, stable field electron emission images of the coated tip arrays were also seen with a reasonable brightness at an electric field 5.6 V/µmm, whereas images of uncoated arrays could hardly be discerned and emission was unstable. Such a remarkable improvement in both field emission and photoemission properties, as compared to those of the uncoated arrays, indicates that the microtip arrays coated with bias-grown diamond films are promising for applications such as flat panel displays. A possible mechanism for the improvement will be discussed. This work is supported by the U.S. Department of Energy, BES-Materials Sciences, under Contract W-31-109-ENG-39.

9:20am **TF-ThM4 Hydrogen Concentration Distribution in Plasma Deposited Hydrogenated Amorphous Silicon and Silicon Nitride Films***, **B.F. Hanyaloglu**, D.C. Marra, E.S. Aydil,* University of California, Santa Barbara

Understanding H distribution in plasma deposited hydrogenated amorphous silicon and silicon nitride (a-SiN:H) films as well as at the interfaces of these films is important for manufacturing of thin film transistors (TFTs) for flat panel display applications. Hydrogen concentration distribution and bonding in plasma deposited a-Si:H and a-SiN:H thin films were studied using in situ multiple internal reflection Fourier transform infrared spectroscopy in conjunction with in situ spectroscopic ellipsometry. The infrared spectra as a function of time were recorded both during deposition of the film and during etching with CF@sub 4@ plasma. The hydrogen concentrations as a function of depth below the film surface were obtained from the spectra recorded during the deposition and the etching experiments. Analysis of the spectra shows that the H distribution in a-Si:H and a-SiN:H films is surprisingly complex and far from uniform. The a-Si:H film consists of a very thin H rich layer at the surface that is primarily composed of SiH@sub 2@ and SiH@sub 3@. This H-rich surface layer is followed by a few 100 Angstrom thick subsurface region that is depleted in H compared to the bulk film. The bulk a-Si:H film grows beneath these two layers, which move up and stay at the surface during deposition. In a-Si:H deposition, there is evidence that H penetrates into the film through a process other than simple diffusion. We have also investigated H distribution and bonding in a-SiN:H films deposited on a-Si:H and a-Si:H films on a-SiN:H in order to study how the deposition sequence alters the chemical composition and structure of the a-Si:H/a-SiN:H interfaces. Implications of these experimental results on the differences in the peformance of top-gate and bottom-gate configuration TFTs will be discussed.

9:40am **TF-ThM5 Poly-Si Thin Film Transistors Fabricated on Low Temperature Plastic Substrates***, **P.G. Carey**, P.M. Smith, P. Wickbolt, S.D. Theiss,* Lawrence Livermore National Laboratory **INVITED**

Flat panel displays made on plastic substrates are envisioned for use in certain commercial and military systems because they are more rugged and lightweight than displays made on glass substrates. High information content can be attained for such displays using active matrix arrays of thin film transistors (TFTs). In this talk the fabrication of poly-Si TFTs on flexible plastic substrates will by discussed. Plastic substrates pose severe temperature constraints on the fabrication process. To overcome these constraints, our group at LLNL has used low temperature (<150C) silicon, oxide, and aluminum thin film deposition steps and pulsed excimer laser processing to perform the TFT channel crystallization and the source/drain doping.

10:20am **TF-ThM7 Stability of Very Low Temperature Amorphous Silicon Thin Film Transistors on Flexible Plastic Substrates***, C.S. Yang, **L.L. Smith**, C.B. Arthur, G.N. Parsons,* North Carolina State University

Active matrix transistor arrays on transparent plastic substrates will enable new high resolution flexible and rugged large area electronic display systems, including liquid crystal displays (LCDs), and organic light emitting displays (OLEDs). Hydrogenated amorphous silicon thin film transistors (TFTs) for active matrix LCDs are currently formed on glass substrates using temperatures in excess of 250°C. Lower temperature processes are of interest for TFTs on plastics, but stability of low temperature TFTs has not been reported. In this presentation, we will describe low temperature (0.3 cm@super 2@/V-s and off currents

10:40am **TF-ThM8 Advanced Deposition Technique for Producing Thin Films of Polycrystalline Silicon***, **J.B.O. Caughman**, D.B. Beach, G.L. Bell,* Oak Ridge National Laboratory

An improved plasma enhanced chemical vapor deposition technique has been demonstrated for depositing poly-crystalline silicon thin films for flat panel display applications. The technique combines a high density radio frequency (rf) inductively coupled plasma source with downstream gas injection that has resulted in device quality films deposited at high rates. Unlike conventional rf reactors, inductively coupled sources have high plasma and atomic species density along with low ion energies hitting the film surface during growth. Our system uses a planar induction coil for the plasma coupling that creates a dense hydrogen plasma over a large area (30 cm diameter). The hydrogen plasma serves as a source of large quantities of atomic hydrogen that aid in the deposition process. For better control of the plasma chemistry, silane (100%) is injected downstream, where the precursors needed for film growth are separated from the ionization region. The films are deposited on quartz samples on a heated substrate (< 400 degrees C). The power coupling mechanism (inductive vs. capacitive coupling) has been analyzed by using an rf sensor (located after the matching network) to determine processing conditions favorable for polysilicon growth. Deposition rates increase substantially with the amount of inductive power coupling and reach values of 60-80 nm/min. Increasing the coupled power beyond 1 kW eventually leads to a decrease in the net deposition rate, possibly due to increased etching of the deposited film by the hydrogen. Deposition results show that the conductivity (10@super -7@ S/cm) and the crystallinity (>80% based on the Raman spectrum) of the films are good. Analysis of the X-ray diffraction spectrum shows a highly preferred grain orientation in the plane. Details of the deposition conditions and the power coupling mechanism will be discussed. @FootnoteText@ Research sponsored by the Laboratory Directed Research and Development Program of ORNL, managed by Lockheed

Martin Energy Research Corp. for the U.S. Department of Energy under contract no. DE-AC05-96OR22464.

11:00am **TF-ThM9 Polycrystalline Silicon Films Deposited Directly on Glass by Reactive Magnetron Sputtering Using a Microcrystalline Silicon Nucleation Layer**, ***D.S. Kim,*** Samsung Advanced Institute of Technology, Korea; *J.E. Gerbi, J.R. Abelson,* University of Illinois, Urbana-Champaign

We investigate the microstructure of polycrystalline silicon (px-Si) thin films which are deposited directly onto glass substrates using reactive magnetron sputtering in a single-pumpdown, two step growth process. px-Si films are of technological interest as thin film transistors in flat panel displays and as absorber layers in solar cells. In the first step, we deposit a microcrystalline Si (µmc-Si:H) film 400 Å can easily be obtained. We will also report preliminary electrical characterizations in both the as-deposited and post-hydrogenated states.

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