Flat Panel Displays
Room 313 - Session FP-MoA
Flexible Displays

Moderator: R.M. Wallace, University of North Texas

2:40pm **FP-MoA3 Microencapsulated Electrophoretic Particle Systems for Flexible Electronic Display Applications***, **P.S. Drzaic**,* E Ink Corporation **INVITED**

The proliferation of portable electronic devices has caused increased interest in new display technologies that overcome the many limitations in traditional flat panel displays. In particular, most current display technologies, particularly those based on fluids, require one or more sheets of glass in the display construction. One strategy for making fluid-based display technologies compatible with film substrates is to create a dispersion of a fluid in a polymer matrix. Microencapsulated electrophoretic displays@footnote 1@ ("electronic ink") offer a unique and interesting set of properties: high reflectivity and contrast, a paperlike appearance, low power consumption, and compatibility with flexible substrates. In electronic ink displays, microcapsules serve to contain a colored, nonaqueous fluid containing electrophoretically-mobile particles. An electric field is used to move particles to either the front or back of the display, so that a viewer either sees the particles or the colored oil. Depending on the surface chemistry of the colloid and polymer, the particles can remain in place long after the electric field is removed. This property gives the display image an inherent persistence of the without further power consumption. Here, I will describe the optical and electrical characteristics of these microencapsulated display materials based on rutile titanium dioxide colloidal particles. Electronic ink devices are also highly compatible with microelectronic circuits, either based on traditional silicon devices or on novel semiconducting organic materials, and I will also discuss recent progress in this integration. @FootnoteText@ @footnote 1@B. Comiskey, J.D. Albert, H. Yoshizawa, J. Jacobson, Nature, 394, 253 (1998).

3:20pm **FP-MoA5 Low Temperature Deposition and Characterization of Polycrystalline Si Films***, **S.I. Shah**, K. Xu, D. Guerin,* University of Delaware

Polycrystalline silicon (poly-Si) thin films were deposited by dc magnetron sputtering at temperatures as low as 150°C on poly(ethyleneterephthalate) (PET) and glass cover slips. Film growth was studied as a function of the partial pressures of argon, hydrogen and krypton and different substrate bias conditions. X-ray diffraction analyses showed that films grown with a gas ratio (Ar: Kr: H@sub2@ = 17:2:1) were polycrystalline. The crystallinity of the films was also dependent on the applied substrate bias. Both the dc bias and the partial pressure of Kr enhanced the adatom mobilities leading to a crystalline film formation. The substrate bias, however, had a critical limit beyond which the crystallinity of the films again decreased. X-ray photoelectron spectroscopy (XPS) depth profiles indicated intermixing at the film-substrate interface. The intermixing was strongly dependent on the ion bombardment due to the substrate bias. We will present TRIM models to explain the effects of both the H and Kr addition to the sputtering gas.

3:40pm **FP-MoA6 Ultra-Barriers of ITO with Low Sheet Resistance***, **C.I. Bright**, M.A. Roehrig,* Presstek, Inc.

The drive to develop Flat Panel Displays (FPD) on flexible substrates has been impeded by the permeability of plastic substrates to water vapor and oxygen which degrade the display medium or electrode materials. Recently, dielectric and ITO thin films barrier layers, separated by polymer layers, vacuum deposited on plastic sheets have demonstrated oxygen and water vapor transmission rates at or below the measurement limits of commercial instrumentation (0.005 cc/m@super 2@day and 0.005 gm/m@super 2@day). We report for the first time, ITO ultra-barriers with performance at or below this measurement limit, produced by vacuum roll to roll deposition. These ITO ultra-barriers, sputter deposited on plastic film substrates, have a typical visible transmittance of > 80% and a sheet resistance of < 20 ohms/square. Details of the deposition process, multilayer construction and measured performance are reported.

4:00pm **FP-MoA7 The Incorporation of High Performance Silicon-based Devices on Flexible Substrates using Self-Orienting Fluidic Transport***, **R. Stewart**,* Alien Technology **INVITED**

PLEASE SEND US AN ABSTRACT. Thank you.

4:40pm **FP-MoA9 Deposition of Silicon Nitride on a Polymer Substrate by Plasma Enhanced Chemical Vapor Deposition***, **D. Guerin**, S.I. Shah,* University of Delaware

Silicon nitride thin films were deposited on poly(ethyleneterephthalate) (PET) by plasma-enhanced chemical-vapor deposition (PECVD) in a capacitively coupled reactor. The process of film growth was examined using X-ray photoelectron spectroscopy (XPS) and atomic force microscopy (AFM). Films were grown for varying lengths of time and transferred under vacuum into an attached XPS system. AFM measurements were performed ex situ. Results indicated that the film growth process was highly dependent on the power density of the plasma. The higher the power density, the longer it took to achieve a pure silicon nitride film. With higher power plasma, the etching of the polymer substrate was observed in the initial stages of the process. This provided carbon and oxygen atoms which get incorporated into the film. Power density also affects the morphology of the thin films. In lower energy plasmas, there is less chemical interaction between the substrate and deposited film. High resolution XPS measurements of the C 1s region indicated that the main effect of the plasma on the substrate was to modify the surface such that an amorphous polymer interface was created between the bi-axial crystalline polymer and the amorphous inorganic film. The little carbon that did get incorporated into the film was C-H bound. Above some critical power density a distinct carbon peak appeared indicating that carbon from the substrate is being incorporated into the film through either Si-C or N-C bonds. AFM measurements revealed that higher energy deposition led to higher nucleation density and surface coverage. XPS measurements, however, continued to show the C 1s peak even after 40 sec. of deposition. In samples deposited at low energy, the C 1s peak disappeared after only 30 sec. of deposition. Based on these observations, we will present a model of the initial stages of silicon nitride growth on PET.

5:00pm **FP-MoA10 Mechanical Properties and Thin Film Transistor Performance for Flexible Displays***, **S. Wagner**, H. Gleskova, Z. Suo,* Princeton University

Flexible displays have become of considerable near-term interest for portable computing and communication devices, because flexibility is equated with ruggedness and light weight. In these applications the displays may be flexed only a few times before they become permanently embedded, often in nonplanar configurations. Longer-term applications include products that will be flexed throughout their entire lives, for example, rollable displays and electronic books. While in some instances display components may be deformed plastically during fabrication, one may seek to exclude plastic deformation during use. Elastic deformation may be induced by bending, coiling, twisting, or stretching. We will focus on the best-understood case of elastic deformation by bending. Three question arise when a thin film transistor (TFT) is subjected to bending: (i) How much bending can a TFT tolerate? (ii) What happens in the TFT during bending? (iii) How does fatigue from repeated bending manifest itself? We have found that: (a) We are beginning to understand elastic deformation of TFT/substrate structures, but still need to understand plastic deformation; (b) Amorphous silicon TFTs are more sensitive to tensile than to compressive strain, and surface passivation may make them more resistant against tensile failure; (c) The mechanical properties of substrate and encapsulation should be tuned such that the circuit comes to lie in the neutral plane.

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