Thin Films
Room 306 - Session TF-FrM
Thin Films on Flexible and Polymer Substrates

Moderator: J.M. Fitz-Gerald, University of Virginia

8:20am **TF-FrM1 Thin Film Electronics on Flexible Polymer and Steel Substrates***, **S. Wagner**, I.-C. Cheng, S.P. Lacour, H. Gleskova, J.C. Sturm,* Princeton University **INVITED**

The flat panel display industry, growing rapidly, is developing flexible displays for its next technology generation. Flexible displays are attractive for light weight and resistance to fracture. They can be bent, conformally shaped, and possibly even stretched elastically. While the optoelectronic functions of flexible displays are similar to those of rigid displays, many of their materials, fabrication processes, and mechanics are new. We will concentrate on transferring the processes for display fabrication from glass plates to flexible substrates, and on the mechanics of flexible substrates. A manufacturer can choose from several display technologies, but only silicon is available for the transistors of the active-matrix transistor backplane. Therefore, the design of a flexible backplane begins with the selection of a foil substrate that is compatible with the silicon thin-film transistor process. The substrate may be an organic polymer or steel. It may need a planarization layer, and must have a layer that provides adhesion, chemical passivation, and electrical insulation. Converting from the chemistry of the substrate foil to the chemistry of a silicon nitride or silicon dioxide passivation layer enables the adoption of many processes developed for glass substrates. The mechanics of flexible substrates plays a role during processing, where it affects device film integrity and mask overlay alignment, and during post-process shaping. Shaping by bending is straightforward and is done in the elastic regime; the device films remain intact. Shaping to a spherical surface, or elastic stretching over an arbitrary surface, produce mechanical strain so large that devices break. A new physical architecture based on rigid device islands has been developed to prevent fracture. Flexible electronics offers a unique combination of materials, processes, devices, and mechanics.

9:00am **TF-FrM3 A Compliant System of Polyimide Microwires for Cryogenic Detector Applications***, **C.A. Allen**, D. Franz, S.H. Moseley,* NASA Goddard Space Flight Center

We have developed a highly compliant, low thermal conductance system of electrical interconnects for cryogenic detector applications. The arrays of microwires are metallic thin film electrical leads supported by a layer of polyimide, capable of spanning the thermally isolated gap between the detector array and the cryogenic heat sink in cryogenic detector assemblies. The low thermal conductance of the microwires enables cryogenic detector thermal isolation without the need for conventional hard wiring, such as soldered manganin or stainless steel. Designed for compactness, an array of 30 microwires fits on a silicon chip less than one half of one square centimeter in total surface area. The free standing length of our microwires is measured in millimeters, as contrasted by units of microns for conventional air-bridge structures. Microwire arrays are terminated on each end by a solid silicon chip containing wire-bonding pads. The two ends of the chip are temporarily supported by a silicon frame, which is removed by laser dicing after the chip has been applied to the detector's thermal isolation platform. We describe techniques for fabrication of arrays of polyimide microwires with several different types of conductive traces, both superconducting and normal-metal. We will discuss their mechanical, electrical, and thermal properties.

9:20am **TF-FrM4 Hysteresis Behaviour during Reactive Sputtering using a Rotatable Magnetron***, **D. Depla**, J. Haemers, R. De Gryse,* Ghent University, Belgium

Reactive magnetron sputtering is a widely used technique to deposit thin compound films on different types of substrates. On laboratory scale the use of a planar magnetron is common practice. However, on an industrial scale one prefers a rotatable magnetron as the target is consumed more efficiently. Unfortunately, detailed experimental results are scarce. Some authors have reported that the well known hysteresis behavior is influenced by the target rotation speed. To study this interesting phenomenon a small rotatable magnetron was developed with a cathode length of only 20 cm making a study on laboratory scale possible. In this paper we present the first results obtained with this device. As we have investigated reactive sputtering of aluminum oxide before using a planar cylindrical magnetron@footnote1,2,3@ this reactive gas/target combination was also used in this study. The discharge voltage was measured as function of the oxygen flow. First, the oxygen flow was increased stepwise until the discharge voltage decreases abruptly, indicating target poisoning. Then the oxygen flow was decreased stepwise. In this way, several hysteresis curves were measured. Two major conclusions can be drawn from these experiments. First, the critical flow to fully poison the target, i.e. when the discharge voltage decreases abruptly, shifts towards lower values with increasing rotation speed. Secondly, we notice that the critical flow to de-poison the target, i.e. when the discharge voltage abruptly increases, also shifts towards lower values with increasing rotation speed but the influence of the rotation speed is much stronger. As such, the hysteresis widens with increasing rotation speed. @FootnoteText@ @footnote 1@D. Depla, R. De Gryse, Plasma Sources Sci. Technol. 10 (2001) 547-555@footnote 2@D. Depla, R. De Gryse, J. Vac. Sci. Technol. A 20 (2002) 521-525@footnote 3@D. Depla, R. De Gryse, Surf. Coat. Technol. 138 (2004) 190-195.

9:40am **TF-FrM5 Bend Testing of OLED Devices on Polymer Substrates***, **J. Lewis**, S. Grego, E. Vick, D. Temple,* RTI International **INVITED**

The flexibility of organic light emitting diode (OLED) displays on flexible substrates is limited by the use of brittle inorganic films for components such as permeation barriers, transparent conductors, and TFTs. The development of a "rollable" display demands significant advances in the mechanical robustness of these brittle films. We will discuss advances in metrology techniques for the mechanical evalution of thin film components, including bend test and failure analysis methods. The fabrication of highly flexible displays requires not only highly flexible component films but also a well-designed display architecture, as layer-layer interactions can lead to mechanical effects not observed when bending components. We will report on the mechanical testing of OLED devices and demonstrate the effects of bending on the current-voltage characteristics, as well as inter-layer propagation of defects. We will discuss the potential impact of the mechanical failure of thin film components on overall device performance and robustness. This work was supported by the Army Research Laboratory (Contract No. DAAD17-01-C-0085).

10:20am **TF-FrM7 Magnetic Thin Film Media on Flexible Substrates by Vacuum Roll to Roll Magnetron Sputtering***, **J. Skorjanec**,* Imation Corporation, US*; C. Merton, M. Hintz,* Imation Corporation

Thin film magnetic media similar to thin film disk has been prepared on polymer substrates by magnetron sputtering in a vacuum roll to roll process. Initial samples to determine film composition, magnetics, and layer thicknesses were prepared in a coupon coater and then transferrred to the roll to roll coater. The roll to roll coater equipment will be described. Some effects of substrate type and deposition parameters on magnetic properties will be discussed. Single pass , multilayer films of long lengths(>300 ft) on polymer substrates were made with final magnetic properties equivalent to the coupon samples with Hc~3400 Oe and Mrt~1memu.cm2.

10:40am **TF-FrM8 Enhanced Properties of IZO Films Deposited on Polymeric Substrate Using Ion-beam Assisted Sputtering for Organic Light-emitting Diode***, **H.C. Pan**, C.Y. Su,* National Applied Research Laboratories, Taiwan, R.O.C.*; C.N. Hsiao,* National Applied Research Laboratories, Taiwan, R.O.C., Taiwan*; Y.-S. Chiu, J.-H. Jou,* National Tsing Hua University, Taiwan, R.O.C.

Zn-doped In@sub 2@O@sub 3@ (IZO) thin films with 5 and 10 wt.% Zn content were prepared on polymeric polyethylene terephthalate (PET) substrate using ion-beam assisted deposition (IBAD) at room temperature. A 15 nm-thick SiO@sub 2@ films were therefore deposited prior to IZO films on PET substrate act as passivation layer to prevent the movement of impurity from underneath layer. The deposited IZO films show amorphous structures with highly electrical conductivity, optical transmittance and surface smoothness on the PET substrate. The 10 wt.% IZO films deposited in a pure Ar atmosphere without IBAD show low resistivity of about 8x10@super -4@ @ohm@-cm, comparable to that of 5 wt.% IZO films (2x10@super -3@ @ohm@-cm). It is found that increase of IZO film thickness leads a high electrical conductivity and decrease of energy band gap regardless of the Zn content of IZO films. The IZO surface morphology increased smoothness with increasing the ion-beam voltage, while the 5 and 10 wt.% IZO film showed a surface roughness variation ranging from 1.7 nm to 1.5 nm and 2.1 nm to 1.5 nm, respectively. Both trends are consistent with more energetic growth condition that enhances the surface diffusion. The energetic contribution of ions with applied 90 V improves the crystallinity of 5 wt.% IZO thin films as shown by a (222)-diffraction peak in the XRD examination. The 5 wt.% IZO films exhibiting higher conducting distribution uniformity with IBAD was characterized using conducting atomic force microscopy (CFAM). The Al/Alq@sub 3@/IZO/SiO@sub 2@/PET stacks were evaluated for flexible organic light-emitting diode (OLED). OLED were fabricated with both 5 and 10 wt.% IZO film electrodes, and the OLED devices with 5 wt.% IZO electrode showed improved electrical performance due to its crystalline than that of 10 wt.% IZO films.

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