

estimated the electron barrier height as 1.1eV, 1.35eV, and 1.55eV for Al, Cr, and Au/ MEHPPV interface, whereas the work functions of Al, Cr, and Au were estimated as 4.0, 4.45, and 4.75eV, respectively. We attributed this discrepancy to the interfacial states formed at the conducting polymer/ cathode interface. It should be noted here that the external dc voltage in three layered device becomes much smaller (1/4 - 1/5) than double layered device consisting of aluminum oxide and MEHPPV. We therefore concluded that the most of the external voltage was applied to conducting polymer, and the suitable energy alignment was obtained successfully by the use of three layered structure.

F3.4

Mechanisms of High Efficient Organic Light-emitting Device with MoO₃ Layers. Chang Ting Lin¹, Guan Ru Lee¹, Chih I Wu¹, Ting Yi Cho², Chung Chih Wu² and Tun Wen Pi³; ¹Graduate Institute of Electro-Optical Engineering, National Taiwan University, Taipei, Taiwan 10617, Republic of China, Taipei, Taiwan; ²Graduate Institute of Electronics Engineering, National Taiwan University, Taipei, Taiwan 10617, Republic of China, Taipei, Taiwan; ³National Synchrotron Radiation Research Center, Hsinchu, Taiwan 300, Republic of China, Hsinchu, Taiwan.

Two high efficient devices will be discussed in this paper. The first is ITO/MoO₃/N,N-diphenyl-N,N-bis(1-naphthyl)-1,1-biphenyl-4,4-diamine (NPB) based organic light emitting diodes (OLEDs). Current-voltage characteristics (I-V) and quantum-efficiency (η -J) measurements show the improvement of device performance with insertion of thin MoO₃ between ITO and NPB. Ultraviolet photoemission spectra (UPS) and core-level x-ray photoemission spectra (XPS) data show that MoO₃ would catch electrons from NPB and results in p-type doping in NPB. In addition, there is a significant structure transition from insulating MoO₃ to metallic MoO₂. As a result of high work function MoO₂ in anode structure and p-type doping NPB, holes can easily be injected from ITO to NPB. The second efficient devices relate to MoO₃/metal structures in tandem OLEDs. Non-stoichiometric MoO₃ films consist of defect states due to O defects which pins the Fermi level in the forbidden gap. I-V characteristics show that with the MoO₃ hole injection layer between anode and NPB, the current efficiency is almost identical, regardless the choice of anodes. We further investigation the interaction between low work function metals and MoO₃. According to UPS and XPS results, low work function metals would easily get O atoms from MoO₃, resulting in the transition to MoO₂ and the increase in conductivity at the same time. The high work function of MoO₃ can be tuned to relatively low work function of MoO₃/Al, Mg anode. These results show that MoO₃ can act as a effective hole injection layer in OLEDs, a charge generation layer in tandem OLEDs, and a high ohmic contact of metal/MoO₃ in top-emitting OLEDs.

F3.5

The Electron Transport Properties and Interfacial Chemical Reactions of Tris-(8-Hydroxyquinoline)-Aluminum Doped With Cesium-Derivatives In Organic Light Emitting Devices. Mei-Hsin Chen¹, Yin-Jui Lu², Chung-Chih Wu² and Chih-I Wu¹; ¹Department of Electrical Engineering and Graduate Institute of Electro-optical Engineering, National Taiwan University, Taipei, Taiwan; ²Department of Electrical Engineering, National Taiwan University; Graduate Institute of Electro-Optical Engineering, National Taiwan University; and Graduate Institute of Electronics Engineering, Nati, Taipei, Taiwan.

The cesium-derivatives (Cs₂CO₃, CsF and CsNO₃) have been investigated as a dopant in tris-(8-hydroxyquinoline)-aluminum (Alq₃) or a thin electron injection layer in organic light emitting devices. Unlike low work function metal which would be evaporated from a complex deposition process, the cesium-derivatives have a very simple deposition process and are easy to handle. By using ultraviolet and x-ray photoemission spectroscopy, the properties of electronic structures and the interface chemistry are studied. The paper presents the investigation of interfacial interactions and electron-injection between cesium-derivatives and Alq₃. According to our results, the Fermi level of Alq₃ after doped with cesium-derivatives shifts inside the gap toward the lowest unoccupied molecular orbital (LUMO) as a result of the charge transfer from cesium atom to Alq₃, showing that electron-injection ability would be improved as a result of strong n-type doping effect. It is noteworthy to emphasize that through the ultraviolet and x-ray photoemission spectroscopy measurement, Cs₂CO₃ does not decompose during evaporation with various evaporation rates and pressures. The relatively abrupt decreasing in vacuum level is found via UPS, which can be explained by charge exchanges and a strong dipole field at the interface with deposition of cesium-derivatives. Moreover, doping cesium-derivatives into Alq₃ not only reduces the electron-injection barrier height, but also increases the carrier concentration for current conduction. We also demonstrate that the interfacial chemical reaction leads to the excellent electron injection efficiency.

F3.6

Linker-free Grafting of Conducting Polymer Films on Various Organic and Inorganic Substrates via Oxidative Chemical Vapor Deposition. Sung Gap Im^{1,2}, Pil J Yoo^{1,2}, Paula T Hammond^{1,2} and Karen K Gleason^{1,2}; ¹Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts; ²Institute for Soldier Nanotechnologies, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Patterns with features as small as 60 nm were resolved in poly(ethylenedioxythiophene) (PEDOT) that is grafted on flexible polymeric substrates. The grafting method propagates conductive polymer chains directly from radical cations generated from phenylene moieties in polymer substrates. With this simple one-step method, PEDOT polymer film can be grafted on various kinds of polymer substrates including poly(styrene), poly(ethyleneterephthalate), polyethylenenaphthalate, polyurethane, and poly(acrylonitrile-butadiene-styrene). An enormous increase in adhesion strength was consistently observed. Even after 3 hours of ultrasonication treatment, the PEDOT film did not delaminate from the polymer substrate. The enhanced adhesion enables high-resolution patterning of grafted PEDOT films using standard lithographic techniques without any modification of the patterning processes. Uniform, well-defined high-density patterns were obtained on over areas exceeding 2 mm × 3 mm. The demonstration of conducting polymer patterns grafted onto common substrates can be a breakthrough for integrated circuitry for flexible electronics.

F3.7

The Functional Hydrophobic Buffer Layer for Enhanced Performance of Organic Thin Film Transistors. June-Yong Song¹, Jae-Il Jung¹, Yoonseuk Choi², Hak-Rin Kim³ and Jae-Hoon Kim^{1,2}; ¹Department of Electronics and Computer Engineering, Hanyang University, Seoul, South Korea; ²Research Institute of Information Display, Hanyang University, Seoul, South Korea; ³School of Electrical Engineering and Computer Science, Kyungpook National University, Daegu, South Korea.

Over the past decade, organic thin film transistors (OTFTs) have attracted much attention for their versatile usages and remarkably progressed in their performances. Especially, to increase the characteristics of OTFTs, various approaches to modify the surface of dielectric layer artificially have been extensively studied because it is a powerful and simple method to improve characteristics of organic semiconducting layer. By controlling the surface characteristic of dielectric, we can obtain a well-organized structure of organic semiconducting layer which is critical to achieve the high performances of OTFTs. Many methods such as self-assembled monolayer and plasma treatment have been investigated so far. However, these conventional techniques are not suitable for practical applications because of inevitable damages of dielectric layer during the

process, and complex procedure. In particular, these cause the poor ordering structure and the reduction of insulating property of organic semiconducting layer, which result in the decreased mobility and poor on/off current ratio of OTFTs. In this research, we introduce the functional buffer layer to modify the surface characteristic of dielectric layer without damaging it. We prepare the material named H1 by using an ingredient of water-proof agent. It has a high hydrophobicity which is known good to improve the characteristic of the organic semiconducting layer. Also, it does not damage the insulating property of the dielectric layer unlike the other methods. As the thin film of H1 can be simply formed by spin-coating and be cured by low temperature process, this method is very powerful to enhance the device performance with simple process. To verify the affinity change of the dielectric layer, we measured the change of the contact angles on the conventional organic insulating material (polyvinyl alcohol, PVA) by introducing H1. A PVA was used as the dielectric material due to its good insulating property. The contact angle was drastically increased from 40° to 107° after spin-coating H1. The unit capacitances of H1 coated PVA and bare PVA were measured as 1.99×10^{-8} F/cm² and 1.94×10^{-8} F/cm² at 1MHz, respectively. This variation is very small compared to other results. These show that the hydrophobic characteristic of the dielectric's surface can be successfully obtained by introducing the proposed buffer layer without losing the insulating property of the device. In final, the OTFTs were prepared by using the pentacene as an organic semiconductor. From the electrical transfer characteristics, the mobility of pentacene on PVA and H1 coated PVA were 6.5×10^{-3} cm²/Vs and 0.18 cm²/Vs, respectively. Almost 30 times increased mobility of OTFTs was obtained by using proposed method in our experiment.

F3.8

Influence of Self-Assembled Organic Thin Film Monolayer on Ambient Copper Surfaces Oxidation. Ilia Platzman¹, Hossam Haick¹ and Rina Tannenbaum^{1,2}; ¹Chemical Engineering, Technion - Israel Institute of Technology, Haifa, Israel, Haifa, Israel; ²School of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, Georgia.

Copper (Cu) has been extensively used as an interconnect material for microelectronic devices due to its high electrical and thermal conductivities and excellent electromigration resistance. However, oxides formed on Cu surfaces cause a decrease in the efficiency of electronic devices, particularly those with submicron dimensions, and hence, there is a need to create a thin protective layer over the Cu surface in order to inhibit the oxidation process. In this work we examined the effect of the formation of self-assembled organic monolayers on the oxidation process of high purity Cu surfaces. Thin films of Cu, prepared by thermal evaporation, showed three main stages of copper oxide growth: (1) Formation of a Cu₂O layer of a thickness $1.4 - 2.2 \pm 0.1$ nm after 6 days of exposure to air at room temperature; (2) Formation of a copper (II) hydroxide Cu(OH)₂ metastable phase that transformed into a more stable copper (II) oxide, CuO, of a thickness $2.2 - 3.2 \pm 0.1$ nm after 60 days; and (3) Steady state. Cu films prepared under the same conditions, but covered with a monolayer of 1,4-phenylene diisocyanide (PDI) molecules adsorbed from solution, showed a decrease in the thickness of the copper oxide layer on the Cu surface. The results indicated that the higher the coverage of the PDI molecules on the Cu surface, the lower the thickness of the oxides layer was. The results showed that the molecules were bound to the Cu substrate through only one of the isocyanide (-NC) terminal groups, while the other was oriented away from the substrate. Our findings imply that chemisorbed PDI monolayers can serve as protective coatings for Cu and, furthermore, as conductive molecular bridges that can potentially bind circuit pads/components in a selective manner in micro and nanoelectronic applications.

F3.9

C60 Fullerenes on the Functionalized Si(111) Surface as a Model for the Interfaces between Biomolecules and Semiconductor Substrates. Xiaochun Zhang and Andrew V Teplyakov; Chemistry and Biochemistry, University of Delaware, Newark, Delaware.

Buckminster fullerenes C60 were used as a model to understand the attachment chemistry of large molecules with amine-terminated self-assembled monolayers (SAM) on semiconductor substrates. This type of interface serves as a prototype for the future devices in such fields as solar energy conversion, biosensing, catalysis and molecular electronics. Fullerenes C60 were attached to 11-amino-1-undecene self-assembled monolayers on Si(111) surface. The chemical state and topography of the C60-modified surface was characterized by surface analytical spectroscopic and microscopic methods and by computational investigation. X-ray photoelectron spectroscopy (XPS) revealed that secondary amine group is formed between the C60 and the amino-undecene SAM on the surface. Infrared spectroscopic (IR) studies verified several characteristic features of C60 skeleton vibration and amino-undecene vibrational signature. The C-H stretching region confirmed that the SAMs produced were well-ordered. The atomic force microscopy (AFM) investigation suggested that the fullerene molecules form surface features with apparent height of ~2 nm and average apparent width of ~20 nm. Parallel study was performed on Au(111) surface for comparison with the results from the silicon substrate. The reaction between fullerene molecules and amino-undecene diluted in decene (~1% v/v) SAM on Si(111) surface yielded accordingly diluted and uniformly distributed C60 molecular features, which indicated that the amine groups were the reactive sites. Preliminary characterizations have revealed the structural and compositional information of the interface between DNA molecules and Si substrate. Microscopic tools such as AFM and contact angle measurement were used to study the change of the surface topography and the change of the surface hydrophilicity or hydrophobicity among each step of the DNA attachment chemistry on Si surfaces accordingly. From the contact angle measurement, it was observed that the hydrophilicity of the surface decreased after attaching the cross linker molecule (SSMCC) onto the amine terminated Si(111) surface and increased after attaching the DNA molecules to the SSMCC modified surface. The AFM images presented the topography change before and after binding of the DNA to the Si substrate, and the topography change after treating the DNA attached surface with DNA digest enzyme. XPS and Time of Flight Secondary Ion Mass Spectrometry (TOF-SIMS) were employed to learn the chemical composition of these interfaces. The results combined from XPS and TOF-SIMS evidenced the present of the cross linker and the DNA molecules covalently bonded on the surfaces. The attachment chemistry of the model system is very robust as confirmed by investigating alternative silicon-based nanostructured substrates, and could be useful for the future applications.

F3.10

Properties of Blue Light Emitting Diodes Coated on Surface Treated ITO/Glass Substrates. Sang Baie Shin¹, Su Cheol Gong¹, Ji Keun Chang¹, Ho Jung Chang¹, Young Chul Chang² and Yong Bin Sun³; ¹Electronics Engineering, Dankook University, Cheonan, Chungnam, South Korea; ²Mechatronics Engineering, Korea University of Technology and Education, Cheonan, Chungnam, South Korea; ³The graduate school of industrial technology and information, Kyonggi University, Suwon, Kyonggi, South Korea.

Generally, organic light emitting diodes (LEDs) are classified into two groups such as low molecule LED and polymer LED (PLED) depending on the applied emitting materials in the devices. PLEDs have attracted much attention for the applications of large and flexible displays because of the simple structure and soluble processes by using spin coating, ink-jet printing and deep coating method. Until now, many researchers have been studied on the PLED devices. However, there are few papers on the effect of ITO plasma treatment and the optimization of film structure. In this study, we fabricated the blue lighting PLED with ITO/PEDOT:PSS/(PVK)/PFO-poss/LiF/Al structure. All organic film layers were prepared by the spin coating method on the plasma and heat treated ITO(indium tin oxide)/glass substrates. PFO-poss [polyhedral oligomeric silsesquioxane-terminated poly(9,9-dioctyl fluorine)] and PVK [N-vinycarbazole] were used as the light emitting and hole transport (electron blocking) materials, respectively. The heat treatment of ITO/Glass substrate was carried out at 180°C for 2 hrs in a vacuum oven. The condition of O₂ plasma treatment of ITO/glass substrate was 100 watt for 30 sec in RF power under 40 mtorr pressure. The electrical and optical properties of PLEDs