Monday Morning, November 2, 1998

Organic Electronic Materials Topical Conference
Room 327 - Session OE+EM-MoM

Organic Thin Film Devices I: Light Emitters

Moderator: A. Kahn, Princeton University

8:20am **OE+EM-MoM1 Polymers for Optoelectronics***, **N. Peyghambarian,*** University of Arizona **INVITED**

Tailoring of organic molecules and polymers has enabled the recent development of multifunctional materials such as photorefractive polymers and organic electroluminescent materials. This talk will review: (i) the development of thermally stable photorefractive polymers with infrared and their application to imaging through scattering media using holographic time-gating techniques; (ii) the fabrication of photorefractive polymer-dispersed liquid crystals; (iii) the demonstration of ultra-bright electroluminescent devices using new Al-based cathodes; (iv) the fabrication of micro-pixel arrays of organic light-emitting devices for displays; (v) the demonstration of optically pumped organic laser structures based on conjugated polymers.

9:00am **OE+EM-MoM3 High Efficiency Three Color Stacked Organic Light Emitting Devices***, **P.E. Burrows**, G. Parthasarathy, G. Gu, S.R. Forrest,* Princeton University*; T. Zhou,* Universal Display Corporation **INVITED**

Vacuum deposited organic light emitting devices (OLEDs) based on "small molecule" organic semiconductors have demonstrated adequate efficiency and lifetime for commercial monochrome flat panel display applications. For full color display applications, vertically stacked OLEDs (SOLEDs) offer increased resolution and aperture ratio over conventional, side-by-side patterned pixels. The SOLED consists of separate red, green and blue elements grown in a vertical stack by sequential vacuum deposition. The elements emit light co-axially through semi-transparent electrodes enabling any combination of three colors to be emitted from the entire area of the device. In this paper we present recent improvements in the color, efficiency and operating voltage of SOLEDs. A typical SOLED is a 13 layer device comprised of organic semiconductors, metal oxides and metal thin films. Understanding and controlling microcavity effects in the stacked device is therefore essential to generate a pixel with well separated and adequately saturated colors. We present an analytical model of weak microcavity effects in SOLEDs and apply the results to fabricate a three color pixel with minimal directionality and good color separation. We also discuss a higly transparent, metal-free cathode which defeats the microcavity effects by reducing reflections within the stack.

9:40am **OE+EM-MoM5 Excited-State Electronic Structure of Conjugated Polymers and Oligomers: Characterization of the Luminescence and Two-Photon Absorption Properties***, **J.L. Brédas,*** University of Mons-Hainaut, Belgium **INVITED**

Conjugated polymers and oligomers present remarkable semiconducting and nonlinear optical properties. They can for instance be incorporated as the active element in new generations of organics-based field-effect transistors, light-emitting diodes, or photovoltaic cells; much work is also devoted to designing chromophores with enhanced second-order or third-order optical response. In this talk, we discuss the results of correlated quantum-chemical calculations aimed at characterizing the electronic structure of these excited states that are responsable for the luminescence and nonlinear optical properties. We focus on polyparaphenylene vinylene and its derivatives; these polymers are widely exploited in polymer-based light-emitting diodes. We describe the nature of the lowest singlet excited states involved in the absorption and emission processes. We then discuss the major influence of interchain interactions; by considering polyphenylenevinylene chains carrying different substituents, we show that some combinations lead to exciton transfer (which is good for luminescence) and others to charge transfer (which is good for photovoltaics). The second (brief) part of the talk deals with the design of novel donor-acceptor phenylenevinylene oligomers which display unprecedented two-photon absorption cross-sections. Some examples of potential applications will be briefly described.

10:20am **OE+EM-MoM7 Gain, Amplified Spontaneous Emission and Lasing in Semiconducting Polymers***, M.D. McGehee, R. Gupta, E.K. Miller, **A.J. Heeger,*** University of California, Santa Barbara **INVITED**

Because of the high absorption coefficients, the high density of chromophores, and the Stokes-shifted luminescence, luminescent semiconducting polymers have potential as low threshold laser media. Optically pumped amplified spontaneous emission has been demonstrated in submicron films of ¼-conjugated polymers as the active materials. Resonant structures appropriate for photopumped lasers include microcavities, distributed feedback (DFB) substrates, and whispering gallery mode micro-discs and micro-rings. Photopumped stimulated emission and lasing have been observed in a growing number of highly luminescent polymers with emission wavelengths that span the visible spectrum. Progress in the areas of polymer lasers will be reviewed and the possibility of electrically pumped diode lasers (fabricated from semiconducting polymers) will be explored.

11:00am **OE+EM-MoM9 XPS and AFM Investigation of Stability Mechanism of tris-(8-hydroxyquinoline) Aluminium Based Light-Emitting Devices***, **Q.T. Le**, F.M. Avendano, E.W. Forsythe, L. Yan, Y. Gao,* University of Rochester*; C.W. Tang,* Eastman Kodak Company

Stability is an essential issue in the application of organic light-emitting devices (OLEDs). We have investigated the indium tin oxide (ITO) surface for operated and un-operated OLEDs that consist of ITO/phenyl-diamine (NPB)/tris-(8-hydroxyquinoline) aluminium (Alq@sub 3@)/Mg:Ag with NPB thickness varied from 0 to 300 Å using X-ray photoelectron spectroscopy (XPS) and atomic force microscopy (AFM) techniques. The ITO surface was exposed by removing the organic and metal layers with dichloromethane, an organic solvent in which NPB and Alq@sub 3@ are highly soluble. Electroluminescence (EL) characterization demonstrates that the NPB layer substantially enhanced the stability. XPS analysis shows that for the device made without NPB and after 90 hours of operation, there exists an insoluble organic material on the ITO surface. This organic material is not observed on the ITO of un-operated cells nor of the operated NPB-containing devices. Lateral force AFM also shows a striking difference between the ITO surface of devices with and without NPB after operation. The XPS and AFM results suggest that the organic residue is the degradation product of Alq@sub 3@ that act as quenching sites at the ITO/Alq@sub 3@ interface, which may lead to the early failure of the single layer devices. This work was supported in part by DARPA DAAL 0196K0086 and NSF grant DMR-9612370.

11:20am **OE+EM-MoM10 A Comparison of the Change in the Valence Electronic Structure of p-sexiphenyl Thin Films upon Doping with K and Cs***, N. Koch,* Technische Universität Graz, Austria*; **J.-J. Pireaux**, L.M. Yu,* Facultés Universitaires Notre-Dame de la Paix, Belgium*; R.L. Johnson,* Universität Hamburg, Germany*; G. Leising,* Technische Universität Graz, Austria

Thin films of the electroactive conjugated material para-sexiphenyl (6P) were doped with potassium and cesium under ultra-high vacuum conditions. The changes in the valence electronic structure of 6P upon increasing dopant exposure were followed with synchrotron ultraviolet photoelectron spectroscopy (UPS), and are compared subsequently. For doping with Cs, new occupied electronic states are only found in the energy gap at 5.8 and 3.6 eV (with respect to the vacuum level); they lie well below the Fermi level, and can be interpreted to negative bipolaron states in 6P. The experimental findings are different when doping with K; for very low doping levels, a finite density of valence states (DOVS) is observed at the position of the Fermi-level E@sub F@ . Higher doses of K lead to a shift of E@sub F@ closer to the vacuum level, and out of the DOVS. This observation could be interpreted in terms of a polaron to bipolaron transition of the charged species of 6P with progressive doping. But also a different interpretation will be proposed, in a manner that bipolarons are formed from the beginning of the doping experiment.

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