# Tuesday Afternoon, November 4, 2003

## Organic Films and Devices
## Room 318/319 - Session OF+EM-TuA

### Molecular and Organic Films and Devices-Optoelectronics

**Moderator:** A.J. Makinen, Naval Research Laboratory

2:00pm **OF+EM-TuA1 OLEDs and Solid State Lighting***, **A.R. Duggal**,* GE Global Research **INVITED**

OLED technology has improved to the point where it is now possible to envision developing OLEDs as a low cost solid state light source. In order to realize this, significant advances have to be made in device efficiency, lifetime at high brightness, high throughput fabrication, and the generation of illumination quality white light. In this talk, the research challenges for general lighting will be reviewed and approaches being pursued at GE to meet them will be outlined.

2:40pm **OF+EM-TuA3 Hybrid Electroluminescent Devices Based on Conjugated Polymers and CdS:Mn/ZnS Core/Shell Nanocrystals***, **H. Yang**, P.H. Holloway,* University of Florida

Nanocrystals with a CdS:Mn/ZnS core/shell structure with a core crystal diameter of 2.3 nm and a shell thickness of 0.4 nm were synthesized via a reverse micelle route. Direct current (dc) electroluminescent (EL) devices were tested having a hybrid organic/inorganic multilayer structure of ITO//PEDOT-PSS//conjugated polymer//CdS:Mn/ZnS nanocrystal//Al, where two different conjugated polymers (poly(N-vinylcarbazole) (PVK) and poly(p-phenylene vinylene) (PPV)) were used. The poly(3,4-ethylenedioxythiophene)/poly(styrenesulfonate) (PEDOT-PSS) layer was used for enhanced hole injection from the ITO electrode. In PVK-based nanocrystal devices, only orange emission from the CdS:Mn/ZnS nanocrystal layer was observed, with no emission from the PVK. However, only green EL emission was observed from the PPV layer in PPV-based nanocrystal hybrid devices, with no emission from the nanocrystal layer. EL emission from a single layer of a multilayer structure was concluded to result from radiative electron-hole recombination occurring predominantly in that layer. All of these data will be interpreted in terms of energy levels for the PVK, PPV, and quantum-shifted CdS:Mn/ZnS structures, where a charge transport through the device depends upon the valence and conduction band offsets at the interfaces between conjugated polymer and nanocrystal layer. In addition, PPV-only EL devices showed much smaller current flow and weaker EL emission than PPV-based nanocrystal hybrid EL devices, suggesting that the CdS:Mn/ZnS nanocrystal layer serves as an electron transport layer (ETL) in the hybrid device. These observations will be shown to be consistent with the energy level diagrams of the EL devices.

3:00pm **OF+EM-TuA4 Large Magnetic Field Effects in Organic Light Emitting Diodes (OLED) based on Alq3***, **A.H. Davis**, K. Bussmann,* Naval Research Laboratory

A study of the spin statistics of exciton formation in organic semiconductors predicts that the amount of light produced by an organic light emitting diode (OLED) can be modulated by controlling the relative spin-polarization of the holes and electrons that combine to form excitons. Organic materials with intrinsically low spin-orbit coupling show long electron and hole spin lifetimes (tS > 1 ms), allowing for the possibility of spin-coherent transport from ferromagnetic electrodes to the recombination zone of a bilayer organic LED. It is important to distinguish this spin-dependent exciton formation and luminescence from other various magnetic field effects (MFE's) observed in the photoconductivity, photoluminescence, delayed luminescence and electroluminescence (EL) of certain organic crystals. We have grown a number of OLED's with magnetic and non-magnetic electrode materials based on a conventional Alq3/NPB organic bilayer and report two magnetic field effects that are present in all devices. The first is a low field effect (LFE) consisting of a one to seven percent increase in EL with an applied field that typically saturates below 1000 Oersteds (Oe). The second is a high field effect (HFE) consisting of an EL decrease by as much as 20+% at 1.8 Tesla (T). Unlike the LFE, the HFE is dependent on temperature, current density and electrode material. This suggests that the LFE and HFE are caused by separate mechanisms and that conditions near the electrode/organic interfaces are important to the HFE. We discuss these results in terms of several possible mechanisms, some of which should be sensitive to the spin-polarization of the injected holes and electrons.

4:00pm **OF+EM-TuA7 The Application of DLC Layer for Polymeric Electroluminescent Devices***, **S.H. Choi**,* Yonsei University, Korea*; D.W. Han,* Samsung SDI*; S.M. Jeong,* Yonsei University, Korea*; H.K. Baik,* Yonsei University, Korea, South Korea*; K.M. Song,* Kon Kuk University, Korea*; S.J. Lee,* Kyungsung University, Korea

The Polymeric electroluminescent devices (PLEDs), which are included with an diamond-like-carbon (DLC) layer between indium tin oxide (ITO) and poly(styrene sulfonate)-doped poly(3,4-ethylene dioxythiophene) (PEDOT) have been fabricated. Indium diffusion, which is due to be etched ITO surface by acidic PEDOT solution into the hole transport layer can degrade the device. It has been used X-ray photoelectron spectroscopy (XPS), and Rutherford backscattering spectrometry (RBS) to measure indium contamination in PEDOT. DLC layer was deposited between hole transport layer and ITO anode by the using the Cs+ ion sputtered negative ion deposition system (CsISNIDS). It was found that device stability and efficiency were seriously affected by indium contamination in HTL and DLC layer could improve device stability. In addition it has been investigated the I-V, L-V characteristics, and Quantum efficiency as a function for a set of devices with and without DLC layer.

4:20pm **OF+EM-TuA8 Photonic Crystals and Nanocomposite Materials***, **J. Ballato**, D. Carroll, S. Foulger,* Clemson University **INVITED**

The promise (some fact and some fanciful) of nanotechnology has led to a well funded global race to develop new materials, components, and devices for use in a remarkably diverse range of applications. Towards the true realization of commercial- and defense-relevant devices, this talk will focus on highly promising results on passive and active photonic devices whose performance is markedly improved, with respect to traditional analogs, through the use of nanocomposite materials. Specifically to be discussed are highly efficient organic light emitting diodes (OLEDs) and photovoltaics (OPVs) fabricated using doped and undoped carbon nanotube-containing conjugated polymers. All-organic photonic crystals based on ordered arrays of nanoparticles encapsulated in elastomeric matrices also will be discussed. These nanocomposites exhibit bandstops that are highly tunable though stain generated by mechanical forces (mechano-chromism) or chemical affinity (chemo-chromism) which opens new doors for optical beam steering and chemical sensing.

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