deposit condensible vapors of metals, semiconductors, insulators and organics. A "multiple jet, moving substrate" strategy allows synthesis of a wide variety of multilayer, multicomponent and alloys. combinations of organic guests and inorganic hosts lead to particularly interesting effects and applications. Substrates on a spinning carousel pass periodically through a sequence of jets; on each pass they accumulate a submonolayer of organic guest, and a thicker inorganic host layer. Organic guests can be trapped at high concentration but nonetheless kept dispersed by fast carousel rotation. The substrate remains cool, and thermally sensitive dyes can be trapped.

By means of this technique we have trapped organic dyes such as Methyl Red and Rhodamine 6G. We describe several applications of JVD host-guest films including passive thin films waveguides, thin film solid-host dye lasers, nonlinear optical films, and chemical sensors.

2:50PM, N4

Heterostructure Electroluminescent Diodes Prepared from Poly(*p*-phenylene vinylene) and Metal-Hydroxyquinoline Compounds: Mark E. Thompson, Chung-Chih Wu, Jonathan Chun, Paul Burrows, Steven Forrest, Richard A. Register and James C. Sturm. Advanced Technology Center for Photonic and Optoelectronic Materials (POEM), Princeton University, Princeton NJ 08544

We report a family of efficient polymer/molecular organic heterostructure light emitting diodes. The diode has a multilayer structure of metal/Mq/PPV/ITO (metal - Mg/Ag, Mq = Al or Ga trisquinolate, PPV = poly(*p*-phenylene vinylene), ITO = indium tin oxide). The PPV precursor is spin-coated onto an ITO film deposited on a glass substrate. Mq is then deposited on the thermally converted PPV film by vacuum deposition. Finally, the top electrode is deposited on the Mq film by vacuum coevaporation of Mg and Ag.

The presence of the Mq layer improves the light emission efficiency of the devices and reduces the reverse bias leakage current. The light emission of these novel LEDs is green and the light intensity is linear with the dc drive current over nearly six orders of magnitude. The external quantum efficiency measured through the bottom of the glass slide is 0.1% and is comparable to other PPV-based LEDs using air stable contracts. In these devices the PPV film acts as a hole transport layer and the Mq film as an electron transport layer. Examination of the elecrtroluminescent spectra from these devices as a function of the thickness of the individual films shows that the origin of electroluminescence can be in the polymer film or the Mq film, depending on the relative thicknesses of the two layers. A model to explain these observations will be discussed.

3:10PM, BREAK

3:30PM, N5* Invited

Progress In Nonlinear Optical Polymers and Devices: Gary C. Bjorklund, IBM Almaden Research Center, 650 Harry Road, San Jose, CA 95120

Nonlinear optical polymers combine the fabrication and cost advantages of polymers with high figures of merit for electro-optic modulation and photorefractive response. This talk will review the recent progress our group has made in the development of high temperature stable poled electro-optic polymers and of photorefractive polymers for holographic data storage. Prospects for device applications will be discussed.

4:10PM, N6

Lifetime of Organic Light Emitting Devices as a Function of Materials, Ambient Atmosphere and Passivation: P.E. Burrows, L.S. Sapochak, D.M. McCarthy, V. Bulovic, M.E. Thompson and S.R. Forrest, Advanced Technology Center for Photonic and Optoelectronic Materials, Princeton University, Princeton NJ 08544.

Organic heterojunction light-emitting devices (OLEDs) have recently generated considerable interest due to their potential application in full color flat panel displays. Red, blue and green OLEDs have now been reported to operate at an external quantum efficiency of 1 to 4%. However, to our knowledge there have been no controlled studies to clarify the factors limiting the lifetime of such devices, despite the fact that rapid deterioration, and the evolution of "dark-spot" defects, is frequently acknowledged, and generally attributed to damage at the interface between the organic and the low work function metal electrode.

In this paper, we study the lifetime of OLEDs consisting of 200Å of an aromatic diamine and 100Å - 600Å of a metal tris-quinolate, $M(OQ)_3$ (where M = Al, Ga, In and Sc). We find that in air, devices run at a constant current of 100mA significantly degrade on a timescale of the order of 10^3s, dependant on the drive voltage. The degradation is typically characterized by 30% increase in drive voltage and a 75% decrease in external quantum efficiency. We have previously shown that conduction in such devices is controlled by trap-limited injection of electrons into the $M(OQ)_3$ layer. The injection efficiency into devices made from $Ga(OQ)_3$appears to be higher than for devices made from $Al(OQ)_3$, allowing the former devices to be run at lower operating voltage (i.e. higher power efficiency). We examine this effect of device composition on lifetime.

We also present results from OLEDs operated in inert atmospheres, showing the effects of the absence of oxygen and water vapor on device lifetime. We demonstrate a packaged OLED, and examine the lifetime of such devices as a function of composition and operating parameters. We also study the effects of "passivating" the devices by overcoating.

4:30 PM, N7

Polymer Electro-Optic Materials: K.D. Singer, T.C. Kowalczyk, and T.Z. Kosc, Case Western Reserve University, Department of Physics, Cleveland, OH 44106-7079. A.J. Beuhler and D.A. Wargowski, Amoco Chemical Co., 150 W. Warrenville Rd., Naperville, IL 60566. P.A. Cahill, C.H. Seager, M.G. Meinhardt, Sandia National Laboratories, Dept. 1811, Albuquerque, NM 87185. S. Ermer, Lockheed Missiles and Space Co., 3251 Hanover St., Palo Alto, CA 94304

Polymeric electro-optic materials are being vigorously investigated for a number of applications such as optical interconnection, modulation, and switching. They possess a number of favorable properties such as processibility and low dielectric constant. The potential for spin-coating and photolithographic definition of waveguides is an attractive approach for multilevel electronic packaging incorporating optical interconnects. The low dielectric constant has permitted high bandwidth devices to be easily fabricated. A number of material issues regarding these applications remain, including thermal stability while maintaining low switching voltage.

Typical polymeric electro-optic materials include a polymer host incorporating nonlinear optical chromophores by doping or covalent attachment. The polymer must be processed with an electric field in order to render it electro-optically active. The electric field process aligns the dipolar chromophores in the polymer; however, this alignment is merely quasistable. A number of approaches has been investigated into materials systems which overcome these limitations.

We describe our current research into a new class of photodefinable polyimide polymer hosts which are doped with new thermally stable chromophores. First, we describe our development of low optical propagation loss polymers. Using photothermal deflection spectroscopy along with waveguide loss measurements, we found that optical losses were dominated by extended absorption tails. The photodefinable fluorinated polyimides minimize these losses. We will also describe the processing of these polymers into channel waveguides

Thursday, June 23, 1994, PM

Session O: Low Temperature Processing and Low Dielectric Constant Materials

Room: UMC, East Ballroom

Session Chairman: Rafael Reif, Microsystems Technology Laboratories, M.I.T., Cambridge, MA 02139

Co-Chairman: Lionel C. Kimerling, Materials Processing Center, M.I.T., Cambridge, MA 02139

1:30PM, O1+

Metal Adsorption on Silicon Surfaces from Wet Wafer Cleaning Solutions: Gerd Norga, Hichem Msaad, Rita Gupta, Jurgen Michel and