SYMPOSIUM J
Materials Engineering for Solid-State Lighting

November 25 – 27, 2001

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*Invited paper
TUTORIAL

FT J: INTRODUCTION TO SOLID STATE LIGHTING

Sunday, May 25, 2001
1:30 p.m. - 5:00 p.m.
Room 203 (Hynes)

Estimated total global consumption of electricity is about 1 x 10^13 kWh per year with 21% of that consumed for lighting. Thus, an improvement of luminous efficiency by 1% may save 2 billion dollars per year. An introduction of new, efficient light sources with high color rendering indices is thus of high importance for energy saving. In his article on solid-state lighting, Nick Holonyak, Jr. stated: "It is vital to know that the LED is an ultimate form of lamp, in principle and in practice, and that its development indeed can and will continue until all power levels and colors are realized." This tutorial on solid-state lighting will cover the following issues: historical survey, vision, photometry and colorimetry, bulbs and tubes, lighting, economy of lighting, light-emitting diodes (LEDs), generation of light, extraction of the light from LEDs, white LEDs, UV LEDs, and present and future applications.

Instructors:
Renuka Gaska, Sensor Electronic Technology, Inc.
Anatbas Zoukoukas, Vilnius University
Michael S. Shur, Rensselaer Polytechnic Institute

SESSION J1: INORGANIC MATERIALS FOR SOLID-STATE LIGHTING I
Chair: Jeffrey S. Nelson
Monday, Wednesday, November 26, 2001
Room 301 (Hynes)

8:30 AM **1.1** PROGRESS IN HIGH POWER, HIGH EFFICIENCY, LONG LIFE SOLID STATE LIGHTING SOLUTIONS. Paul S. Martin, Lumileds Lighting, San Jose, CA.

Lumileds' recent advances in AlInGaP device design, AlInGaP device design for high power packaging and phosphor-conversion technology have brought LEDs into new markets for solid state lighting. These markets require high flux density, high efficiency and high reliability. The traditional 5 mm LED cannot provide. This talk will describe recent advances in red, green and white LEDs that surpass the 100 lm/LED benchmark and illuminate a path into the future for solid state lighting.

9:00 AM **1.2** OPTIMIZATION AND MANUFACTURABILITY OF SHORT WAVELENGTH BLUE, VIOLET AND ULTRAVIOLET ALGaNP LEDS FOR WHITE LIGHT APPLICATIONS. May H. Crawford, Kevin C. Baus, V. S. Sreekumar, Vishwanath Krishnamoorthy, Eric C. Breitkreucher, Christopher J. Eiting, Michael G. Brown, Jeffrey S. Nelson, Uniroyal Opto-Electronics, Tampa, FL.

Semiconductor-based light emitting diodes (LEDs) have made strong inroads into monochrome applications such as signal lighting and displays, however more development is needed to make a substantial impact on white lighting applications. The primary limiting factor at this time is the relatively low efficiency of commercial white LEDs. One method to improve white light involves the use of blue or near-UV InGaN LEDs in conjunction with wavelength conversion materials such as phosphors. In this talk, we present the optimization and performance of near-UV to blue wavelength LEDs (380 nm-460 nm) for the specific application of phosphor-based white lighting. Our main focus will be the comparison of material and device performance with different approaches. Critical material issues such as device yield and reliability will also be addressed.


An ultraviolet light emitting diode with peak emission wavelength at 340 nm is reported. The active layer for the device comprised of quaternary AlInGaNP/AlInGaP multiple quantum wells, which were deposited on sapphire substrates using a new pulsed atomic layer epitaxy process. This novel approach of fabricating AlInGaNP layers by the repetition of a unit cell with atomic dimensions allows for a precise control of the composition and thickness. The device epitaxial structures consisted of the active MQW surrounded by Mg-p-type barrier and injection layers. Both the barrier types consisted of AIGaN/AlGaN superlattices to enhance conductivity and improve surface morphology. These epilayers were characterized using PL, X-ray, AFM and Hall measurements. Subsequently, ultraviolet emission from etched LED structures were fabricated. Comparative study of devices over sapphire and SiC substrates was done to determine the influence of epilayer design on the performance parameters and the role of the substrate absorption. We were able to obtain power as high as 0.12 mW at 340 nm with a FWHM of 15 nm. This points to an excellent potential of our quaternary active layers approach for deep UV LEDs. New device designs with much improved carrier confinement are being fabricated to further increase the emission powers. The influence of these new designs on emission properties will also be discussed.

9:45 AM **1.4** ELECTRON BEAM DISSOCIATION OF Mg-H CENTERS IN Mg-DOPED GaN. C.H. Seeger, N.A. Misser, S.M. Myers, Sandia National Laboratories, Albuquerque, NM.

While it is known that minority carrier injection from n layers and direct injection of 10-20 kV electrons with an electron gun can create p-type conduction in an Mg-doped GaN, the details of the de-passivation process are poorly understood. We have studied this process by carefully controlling our electron beam uniformity, dose, and dose rate while accurately measuring both the infrared vibrational signature of Mg-H centers and the cathodoluminescence (CL) from Mg-H-doped GaN. We find that the dose of the order of 8 x 10^10 cm^-2 reduce the optical absorption from this center by ~20%; however, much higher doses result in ~1/2 of the hydrogen still bonded at substantially Mg sites. Concurrently, with the electron beam exposures we find large changes in the CL spectra including a luminescence peak which is strongly correlated with H content and which displays a significant red shift as the de-passivation process evolves. We also observe that at 500°C (5 minute) thermal anneals restore the size of the Mg-H absorption, indicating that the e-beam-debonded hydrogen has not left our samples. We will compare the rate of the electron beam bonding process for H and D containing GaN and use this information to speculate on the nature of the bonding process.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.

10:30 AM **1.5** III-NITRIDE MICRO-SIZE LIGHT EMITTERS FOR SOLID-STATE LIGHTING APPLICATIONS. H.X. Jiang and J.Y. Lin, Department of Physics, Kansas State University, Manhattan, KS.

Bright blue LEDs based on III-nitrides paved the way for full color displays and raised the possibility of mixing three primary colors to obtain white light for general illumination by semiconductor LEDs. The most common approach for achieving white light using LEDs is to use a phosphor to down-convert the emission from a blue or UV LED. In such an application, improving the LED efficiency is a key step. Most recently, we have succeeded in fabricating III-nitrides pumped microdisk LEDs, as well as in interconnecting hundreds of these microsize LEDs (size on the order of 10 microns in diameter) made from InGaN/GaN MQW light emitter structure. These interconnected microdisk LEDs fit into the same device area taken up by a conventional LED of about 300 x 300 μm². It was shown that the interconnected microdisk LEDs could boost the LED emission efficiency by more than 60%. It is believed that the novel device can overcome two biggest problems facing LEDs - the low extraction efficiencies due to the total internal reflection occurring at the LED/air interface and the problem of current spreading. Additionally, the strain induced piezoelectric field in the active quantum well region may be reduced in micro-size devices, which could increase the internal quantum efficiency. Furthermore, the processing steps of these interconnected micro-size LEDs are the same as those of the conventional broad-area LEDs. It is thus expected that the manufacturing yield of these novel interconnected micro-size LEDs to rival with the conventional LEDs. The present method of utilizing micro-size LEDs can be further developed to boost the LED emission efficiencies for solid-state lighting applications, as well as for UV light emitters to be used for chemical and bioluminescent substances detection.

11:00 AM **1.6** ALTERNATIVE SUBSTRATES FOR GaN-BASED LEDs. T.J. Anderson, O. Kyvelis, M. Reed, M. Martinez and T. Dunn, Chemical Engineering Department, University of Florida, Gainesville, FL.

The emergence of relatively high brightness GaN-based LEDs emitting in the blue and near-UV has encouraged their use in white
lighting applications. Further improvements in brightness and process yield, however, are necessary to realize broad commercialization. The large lattice and thermal mismatches between GaN and sapphire or SiC have motivated the investigation of alternative substrates. This presentation will focus on the growth of GaN on nearly lattice-matched LiGaN₂O₄ and LiAlO₂ substrates, as well as growth on Si. We report on successful growth of single-crystal GaN substrates by MOVCD on LiGaN₂O₄ and LiAlO₂, and using the high growth rate possible with Hydride Vapor Phase Epitaxy to produce free standing GaN. Keys to obtaining high-quality GaN films on LiGaN₂O₄ are an initial surface step followed by growth of a MoCVD buffer layer. The use of hydrogen as the carrier gas and avoiding the buffer layer was possible when using LAO as a substrate. A self-separating technique was developed that leaves freestanding free single-crystal GaN without mechanical or chemical treatment. This study has shown that surface nitridation and cooling process are critical to delaminating.

11:30 AM J.17
A NOVEL SAPPHIRE SURFACE GROWTH PROCESS FOR LED SUBSTRATE APPLICATIONS. Hyungsong Piek, Helen M. Chen, Lehigh University, Dept of Materials Science & Engineering, Bethlehem, PA.

At present, sapphire substrates for blue LED and laser diode applications are prepared by a combination of mechanical and chemical polishing. The ensuing device performance is highly dependent on the quality of the surface finish, and degree of subsurface damage. Results will be presented on a new approach to generating a pristine surface layer, starting with a sapphire substrate mechanically polished to a 3 micron mirror finish. The process consists of oxidization of a thin surface film of Al, followed by solid phase epitaxy of the underlying substrate. Development of the surface layer was studied using SEM, OIM (orientation imaging microscopy), X-ray diffraction, and AFM. The influence of cooling temperature and heat treatment time/temperature on the final surface finish will be discussed. The proposed method has the potential to be more cost-effective than conventional techniques, and would be compatible with current device manufacturing procedures.

11:45 AM J.18

GaN is attractive for fabrication broadly tunable laser with diode pumping where diode structures are grown directly on laser crystal. One of the most prospective materials for the application is titanium-doped sapphire. It is well known that laser generation in Al₂O₃:Ti⁺⁺ is available in the range 675-695 nm [1] and from the other hand sapphire is preferred substrate for the growth of GaN based LED heterostructures. There is the opinion that shifting of the emission maximum of the heterostructures to the peak position of the Al₂O₃:Ti⁺⁺ absorption spectrum by changing of In/ Ga ratio in nitride composition has to provide effective pumping such device. The present work is the first step in this direction. The ribbons Al₂O₃:Ti⁺⁺ crystals have been produced by Stepanyuk’s (EFG) technique from the melt using special shaper. The pull rate was typically 0.15-0.3 mm/min. The crucible charge consisted of crystal Al₂O₃ and powder of TiO₂ (0.1 percent by weight). The grown 18 mm wide ribbons were slightly crimson, self-seeded by basal plane (0001) and looked mirror like. 3-5µm-thick GaN epitaxial layers have been deposited on the sapphire surface of the ribbons without any buffer layers in hot-wall horizontal HVPE reactor operated at 950-975°C. The investigation of PL and CL spectra of the layers and the substrates has shown that they are typical for high-quality GaN and Al₂O₃:Ti⁺⁺ crystals. 1. G.S. Kruglik, G.A. Sripkio, A.P. Shkharevich et al. Quant. Electronics [Russian] 13, 1207 (1986).

SESSION J2: INORGANIC MATERIALS FOR SOLID-STATE LIGHTING
Chair: Alan P. Wright, Monday Afternoon, November 26, 2001, Room 301 (Hynes)

13:00 PM J.2.1
WHITE LIGHT BASED ON SEMICONDUCTORS. E. Fred Schubert, Department of Electrical and Computer Engineering, Boston University, Boston, MA.

This talk will review experimental and theoretical results on a GaN-based LED capable of emitting white light with high efficiency. The LED consists of a current-injected blue LED and an electrically passive but optically active photonic region. Several characteristics of the photonic-recycling semiconductor LED, including the luminous performance, color rendering properties, and current crowding, will be discussed.

2:00 PM J.12.2
TECHNICAL AND COMMERCIAL CHALLENGES FOR ILLUMINATION WITH BLUE/UV AND PHOSPHOR SOLID STATE LIGHTING. Robert F. Karleke, Jr., GE Lighting, Valley View, OH.

It is widely recognized that the development of high brightness GaN based LEDs has created demand for the development of solid state lighting systems for general (white light) illumination. In order for solid state lighting to become cost effective, LED illumination performance must be increased by a factor of 5 to 10 fold in the next 5 to 10 years. This talk will review the technical and market challenges faced by LED solutions for illumination, contrast the various approaches which can use LEDs to produce white light, and look at improvements in conventional lighting systems which will continue to challenge LED based solid state illumination developers in the near future.

2:30 PM J.2.3
DEGRADATION STUDIES OF AlGaN/P HIGH-BRIGHTNESS LIGHT EMITTING DIODES. A. Jaeger, P. Staaas, N. Lieder, K. Streubel, B. Oberschmid, OSRAM Opto Semiconductors, Regensburg, GERMANY.

Visible light-emitting devices (LEDs) are of utmost importance for many applications such as backlighting, signage, and indoor display back-lighting and in the near future for general lighting. Compared to conventional incandescent bulbs LEDs have several advantages including higher luminous efficacies and higher reliability. These goals require an optimized epitaxial growth. Additionally, we utilize an improved contact geometry and a new type of surface texturing. AlGaN/P LEDs with a dominant wavelength of 615 nm and different thicknesses of spacer layer between the active multiquantum well region and the p-contact layers are analyzed by both optical and electrical measurements during long-term high-brightness operation. Light-current characteristics supplemented by current-voltage characteristics reveal a strong dependence of device reliability on the layer design. LEDs with a thin spacer layer suffer from a strong increase of non-radiative recombinations processes in the active layer resulting in reduced optical power during the first 600 hours. In contrast, a thicker spacer layer improves considerably the reliability of LEDs with no changes during the first 600 hours. This result can be understood in terms of the different concentration of non-radiative defects connected to p-doped Mg atoms in the device which can be activated during operation. In conclusion, we demonstrate analytical tools which are sensitive to gradual operation-induced changes of high-brightness LEDs and allow insights into the aging mechanisms occurring during long-term operation. Highly reliable AlGaN/P LEDs are fabricated by an optimized epitaxial growth design.

2:45 PM J.2.4
LOW-TEMPERATURE GROWTH OF SiC FUND IN HARDSHIPS ON Si[111] SUBSTRATES. Radek Rozek, Arizona State University, Department of Physics and Astronomy, Tempe, AZ; John Telle, Arizona State University, Department of Chemistry and Biochemistry, Tempe, AZ; David J. Smith, Arizona State University, Department of Physics and Astronomy, Tempe, AZ; Peter Crozier, Arizona State University, Center of Solid State Science, Tempe, AZ; I.T. Toong, Arizona State University, Department of Physics and Astronomy, Tempe, AZ; John Koutetakis, Arizona State University, Department of Chemistry and Biochemistry, Tempe, AZ.

Thin films and coatings of the solid solution SiC:N are deposited on Si[111] substrates at low temperatures using a completely new approach based upon thermally activated reactions of a unimolecular precursors H₂SiCN with Al atoms from a Kräussn coil in a molecular beam epitaxy (MBE) chamber. The reaction proceeds SiC:N films accompanied by the elimination of hydrogen in a byproduct. The reaction proceeds at substrate temperatures in the range of 580-700°C, considerably lower than previous attempts in the growth of similar composition. Fourier transform infrared spectroscopy (FTIR) in the transmission mode shows two broad peaks at wave numbers 237 cm⁻¹ and 660 cm⁻¹ corresponding to Si-C and Al-N lattice vibrations respectively. Elemental concentration of the films determined by Rutherford backscattering spectroscopy (RBS) shows Si ∼ 25 at. %, Al ∼ 27-29 at. %, C ∼ 24-25 at. %, and N ∼ 24-26 at. %, High resolution cross-sectional transmission electron microscopy (XTEM) images of the SiC:N films show columnar growth with a wurzite structure with lattice constants a = 4.05Å determined from electron diffraction patterns, close to those of
STACKED ALGaN/GaN DOUBLE HETEROSTRUCTURES FOR MULTICOLOR AND WHITE LIGHT EMISSION
S.M. Heikenfeld and A.J. Steckl
University of Cincinnati, Nanoelectronics Lab, Cincinnati, OH.

We have developed a novel display structure which has improved the brightness and fabrication feasibility of rare earth (RE) doped GaN devices. [1] Through use of hexagonal GaN growth on an AlN/InGaN/SiO2/AlN substrate, GaN:RE phosphors are now compatible with the same substrates utilized in active matrix liquid crystal display manufacturing. Furthermore, screen-printing of a high-yield, high-confinement (~1000) phosphor-doped dielectric film has been developed for use as a phosphor layer in an alternating current EL device. This high brightness, high stability of GaNRE phosphors makes possible the fabrication of this new phosphor-doped dielectric (TPED) device on glass substrates. White and primary color light emission from red (GaN:Eu), green (GaN:Er), and blue (GaN:Tm) TPED devices has been demonstrated. For biasing at 1 kHz, GaN:RE EL brightness has been increased by an order of magnitude for all thin film EL devices to ~40 cd/m² for TPED devices. Furthermore, TPED device contrast measured in 540 kHz back lighting has been improved to nearly 10:1 for 120V, 1 kHz biasing. The aging of GaNRE display devices has been improved to the point where after 1000 hrs of operation only a 5% reduction in brightness is observed. GaNRE TPED devices provide key fabrication advantages required for display technology in development for 3D high-definition TV. Through use of the GaNRE phosphor, the additional advantages of reduced fabrication steps and use of standard display glass are incorporated. The combination of these features indicate the significant potential of GaNRE phosphors for future displays. [1] J. Heikenfeld and A.J. Steckl, Appl. Phys. Lett. 77 (22), 3520 (2000); [2] S. Grosman, Electronic Design, p. 25, May 1 (2000).

THEORETICAL STUDIES OF METAL COMPLEXES AS PHOSPHORS IN LIGHT EMITTING DIODES
P. Jeffrey Hay and Richard L. Martin, Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM

Heavy metal complexes are receiving increased attention as efficient phosphors in organic light emitting diodes (OLEDs). Electron-hole recombination may utilize phosphorescence from the lowest triplet state rather than fluorescence from the lowest singlet state to achieve higher efficiencies. Relying upon recent advances in time dependent density functional theory (TDDFT), we have studied the nature of the lowest excited states in Ir(ppy)_3 complexes with potential OLED applications. We find that the TDDFT approximation, using hybrid density functionals, provides a surprisingly quantitative reproduction of the excitation energies in these traditionally challenging organic systems. For a series of Ir(ppy)3(L) complexes studied experimentally by Thompson et al., we examine the nature of the low-lying metal-to-ligand charge transfer (MLCT) states and how they vary as a function of L. The photophysical of the lowest triplet state in the Pt(porphyrin)3 complex Pt(OEP) has also been investigated.
(p-phenylene vinylene) light-emitting diodes to determine the excitation processes that lead to radiative recombination from the phosphorescence. Possible positions for the phosphorescence were considered: 1) sequential electron and hole capture by the phosphor; 2) energy transfer from the polymer triplet excitation (Dexter transfer); and 3) energy transfer from the polymer singlet exciton (Forster transfer). The properties of the doped polymer were investigated for doping levels up to about 20%. At the highest doping density, all radiative recombination occurs in the phosphor molecule and the observed electroluminescence decay time increased compared to the undoped polymer. Further increases in the doping level from the donor side were observed by the absorption spectrum of the phosphor. Measurements of triplet optical absorption show that the triplet population in the polymer is not affected by the presence of the phosphor indicating that Dexter transfer processes are weak. In an analogous chemically substituted polymer, no excitation transfer occurs with an energy migration to the excitation spectrum of the polymer and the absorption spectrum of the phosphor. These results demonstrate that the only active excitation transfer path from the polymer to the phosphor is dipole-dipole coupling. These conclusions are consistent with the charged and neutral electronic excitation energies of the polymer and phosphor determined by hybrid and time-dependent, density-functional theory calculations.

10:15 AM J3.3.5
HIGH SPEED PULSE RESPONSE OF OLED WITH RUBLINE DOPED THIN EMISSIVE LAYER AS A LIGHT SOURCE FOR PHOTOVOLTAIC INTEGRATED CIRCUITS. Tadeo K., Takahisa Tsugawa, Masayo Yasumori and Hiroko Kaji, Osaka University, Collaborative Research Center for Advanced Science and Technology (CRCAST), Suita, Osaka, JAPAN.

Organic electroluminescent devices (OLED) have been attracting great interest for flat panel display applications. A significant advantage is that they are for simple fabrication on various kinds of substrate, including polymer substrates and have a capability of an integrated optical circuit with OLED and polymer waveguide. In this presentation, we demonstrate the device characterization of an OLED for the light source of polymer waveguide. The OLED consists of a thin layer of emitting polymer (5,6,11,12-Tetracenevinylidylenecyclopenta[2,1-b:3,4-b′-de]anthracene) doped in Alq3 (8-hydroquinoline aluminium) and a hole transporting layer of α-NPD (N,N-di(naphthalene-1-y1)-N,N-diphenyl-benzidine). The device emits yellow light centered at 550 nm with 1.60% of rubrene doped in Alq3. Since the polymer waveguide used in our experiments have the low propagation loss at the longer wavelength side, the yellow emitting OLED with rubrene has the advantages of relatively low propagation loss and the high emission intensity. The device emits more than 30,000 cd/m2 at the current density of 3 A/cm2, and has a response speed of more than 30 MHz with the device of 0.1 mm electrode area. The OLED is directly driven at an applied voltage of 10 ± 15 V, and the output light is monochromated through the waveguide. The OLED with (4,6-(dicyanomethylen)-2-methyl-4H-pyran) doped in Alq3 have similar response characteristics, however, the emission intensity is stronger in doped Alq3 than that in DCM doped device. The details of the device fabrication and their emission characteristics are discussed.

10:30 AM J3.3.6
OPTICAL PROPERTIES OF META-PARA POLY(pHENYL-LENEVINYLENES). Alexander Poganski, Egbhart Zojer, Emil J.W. List, Technische Universitat Graz, Institut fuer Festkoerperfysik, Graz, AUSTRIA; Jean Luc Bredas, The University of Arizona, Department of Chemistry, Tucson, AZ and Service de Chimie des Matériaux, Centre de Recherche en Electronique et Photonique Moleculaires, Université de Mons-Hainaut, Mons, BELGIUM; Guenther Leising, Science and Technology ATOS AG, Leoben, AUSTRIA and TU Vienna Nanotechnology and Photonik, Joanneum Research, AUSTRIA; Kai Mühler, Gertraude Haun, Robert Saf, Franz Stohler, Institut fuer Chemische Technologie Organischer Stoffe, Technische Universitat Graz, Graz, AUSTRIA.

Alternating meta and para substitutions along a poly(phenylene- vinylene) (PPV) chain is a way to achieve a decreased conjugation at the methylene resulting in a blue shift of the emission color compared to the exclusively para-linked polymer. Additionally, one can expect to increase the quantum efficiency in these materials by inhibiting exciton migration to chemical defects acting as quenching centers. We investigated the properties of several different new synthesized meta-para PPVs by means of UV-VIS and photoluminescence spectroscopy as well as photo-induced absorption. Electroluminescent devices possessing a blue emission color were prepared. In order to study the effect of the meta units on the conjugation in more detail the polymerization product was fractionated by GPC resulting in oligomers of different chain lengths.

10:45 AM J3.3.7
ON THE RISK OF KETO DEFECTS IN THE DEGRADATION PROCESS OF POLYFLUORENE TYPE MATERIALS. Emil J.W. List*, Roland Günster*, and Ulrich Scherf,* Institut für Festkörperfysik, Technische Universität Graz, Graz, AUSTRIA; Institut für Physikalische und Theoretische Chemie, Universität Potsdam, Golm, GERMANY.

We present spectroscopic evidence for the formation of keto defect sites in 3-monohydroxy-fluorenes (mono-PF) which are identified as the source of a strong low energy emission band at 2.3 eV = 520 nm. This observation, which has been found in polyfluorenes and ladder-type poly(p-phenylene) in photoluminescence (PL) and electroluminescence (EL) emission spectra, makes the often favored interpretation of this low energy emission band, by an ongoing aggregation or excimer formation questionable. Using UV-VIS, photoluminescence emission and infrared spectroscopy we have identified the keto defects in 3-monohydroxy-fluorenes using key energetic trapping sites for single excitons, which are populated by an excitation energy transfer from the polyfluorene. Moreover we find a much stronger contribution from the keto emission in EL than in PL, which is attributed to charge carrier trapping at the keto site and subsequent EL in addition to excitation energy transfer of single excitons from the polyfluorene to the keto site. Note that 3-monohydroxy-fluorene which has been characterized for comparison did not show any keto defects in its pristine form. The keto defects can hence be generated directly during polymer synthesis as show for the mono-PF or can be formed as main channel of a photo- or electro-oxidative degradation process. The presented novel results therefore strongly indicate the key role of keto defects in the degradation effects of PF type materials and PF containing polymer light emitting devices.

11:00 AM J3.3.8
PHOTOPHYSICAL PROPERTIES OF DENDROMIC POLY-FLUORENES AND THEIR APPLICATION IN LIGHT EMITTING DIODES AND POLYFLUORENES. Alexander Poganski, Franz P. Wenzl, Emil J.W. List, Technische Universitat Graz, Institut fuer Festkoerperfysik, Graz, AUSTRIA; Seppo Setamoh, Andrew C. Grimsdale, Heinz G. Nothofer, Klaus Moellen, Max-Planck-Institut für Polymer Research, Mainz, GERMANY; Guenther Leising, Science & Technology ATOS AG, Leoben, AUSTRIA.

Shielding a polyfluorene backbone with oligophenylene (Moellen-type) dendrons is a promising way to reduce interchain interactions that usually destructively influence the emission properties of the material, while retaining good charge transport capabilities. We have characterized the material using UV-VIS and photoluminescence emission spectroscopy. Upon photoexcitation only emission from the polyfluorene backbone is detectable. We have found no additional emission bands neither at lower energies nor from the dendritic side chains. Utilizing time resolved fluorescence spectroscopy we present evidence that the interchain migration of excitons is reduced in dendron-protected polyfluorenes compared to non-protected ones. Photoinduced absorption measurements reveal low triplet and polymer formation rates upon photoexcitation and an excited state absorption that is spectrally well separated from the emission of the material. Using the material as the active layer in polymer light emitting diodes yields no overlap between deep blue emission with onset voltages of about 6 V and a luminance of 400 cd/m2 at 8 V. Operating the device under pulsed excitation results in a shift of the recombination zone further improving the emission color by influencing the self absorption conditions.