

Electrophosphorescence in Ladder type Poly(*para*-phenylene) Derivatives

Satish Patil¹, J. M. Lupton², A. Pogantsch³, T. Piok⁴, E. J. W. List^{3,4}, U. Scherf¹

¹Bergische Universität Wuppertal, Makromolekulare Chemie, Gauss Str. 20, D-42097 Wuppertal

²Ludwig-Maximilians-Universität, Lehrstuhl für Photonik und Optoelektronik, Amalienstr.54, D-80799 München

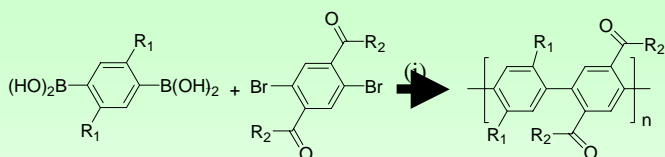
³Institute of Solid State Physics, Graz University of Technology, A-8010 Graz

⁴Institute of Nanostructured Materials and Photonics, A-8160 Weiz, Austria

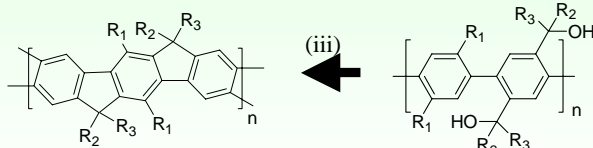
Introduction

Ladder-type polyphenylenes are interesting class of materials due to their high degree of purity and their intense blue emission¹. The undoped polymers show no emission from triplet states. We show that only a small amount of incorporated palladium atoms is sufficient to allow efficient triplet emission without the modification of the electronic properties of the conjugated polymer. The conjugated polymer under investigation is the phenyl derivative of the well-known ladder-type poly(*para*-phenylene) LPPP (Ph-LPPP).

Synthesis of Ph-LPPP

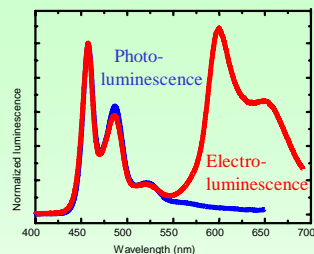
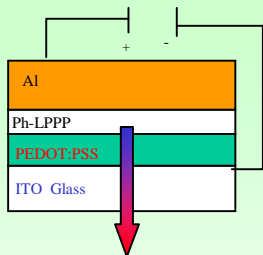


$R_1 = \text{hexyl}$ $R_2 = 4\text{-decylphenyl}$ $R_3 = \text{Ph}$



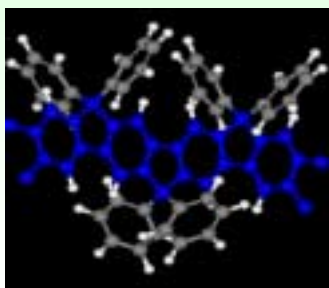
(i) Pd(0), Toluene, Na₂CO₃ aq., reflux 3d (ii) Ph-Li in diethyl-ether (iii) BF₃*etherate

Light emitting diode from Ph-LPPP

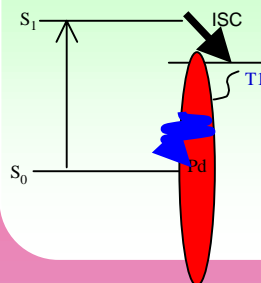


(i) Photoluminescence spectrum of Ph-LPPP displayed typical LPPP blue emission at ca. 450 nm.

(ii) However, in the electroluminescence spectra two further features are observed at 600 and 650 nm which we assign to electrophosphorescence.

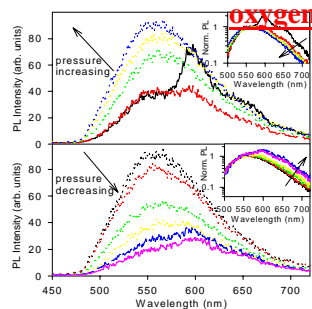


Origin of Phosphorescence in Ph-LPPP



The ICP-OES analysis of Ph-LPPP revealed 80 ppm palladium content. This covalent attachment of palladium atoms leads to efficient phosphorescence at room temperature. The increased incorporation of Pd in Ph-LPPP is probably due to the high affinity of Pd to phenyllithium, which is used in the reaction sequence to Ph-LPPP.

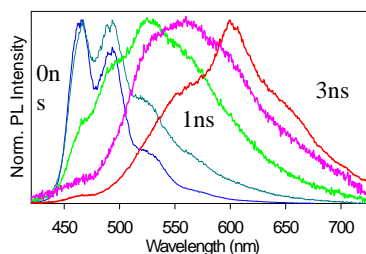
Phosphorescence sensitivity to ambient



Phosphorescence vanishes upon purging with air.

Phosphorescence Reappears upon evacuation

Time resolved PL spectra of Ph-LPPP



Delayed PL Spectra at 295 K excited at 380 nm and detected at 0-40 ps, 100-140 ps, 300-400 ps, 1-2 ns and 3-4 ns reveals phosphorescence in solution also

Conclusion

1. We have successfully synthesized Ph-LPPP with reproducible palladium content.
2. We have demonstrated a novel route for triplet harvesting from conjugated polymers by inclusion of a small amount of metal.
3. The electronic properties of the polymer are not affected by the isolated metal sites.
4. The radiative decay of triplet provides novel tool to study the energetic structure and dynamics of triplet.

References :

1. J. M. Lupton, A. Pogantsch, T. Piok, E.J.W. List, S. Patil, U. Scherf, *Phys. Rev. Lett.* 89, 16, 16401, (2002).
2. U. Scherf, *J. Mater. Chem.* 9, 1853, (1999).