

Electroluminescence from Polymer Blends of Poly(3-*n*-butyl-*p*-pyridyl vinylene) and Poly(9-vinylcarbazole): C.C. Wu, J. Tian, J.C. Sturm, M.E. Thompson, and R.A. Register, Princeton University, Advanced Technology Center for Photonic and Optoelectronic Materials, Princeton, NJ 08544

In this work, we study LEDs made from polymer blends composed of a hole-transporting polymer, poly(9-vinylcarbazole) (PVK) and the conjugated polymer Poly(3-*n*-butyl-*p*-pyridyl vinylene) (Bu-PPyV). The high solubility of Bu-PPyV and PVK allows the fabrication of LEDs from their blends of various ratios. Through blends of these two luminescent polymers, we show that it is possible to modify the electrical and optical properties of the polymers in ways not possible with pure materials, and also to identify the origin of the emission in pure Bu-PPyV. The electroluminescence (EL) of the pure Bu-PPyV thin film is in the orange-red range of the spectrum, with its peak position beyond 600 nm. Furthermore, Bu-PPyV is of special interest because in its protonated form it can be used for the electrostatic self-assembly of polymer monolayers. The LEDs made from the pure PVK emit violet light, with its peak around 420 nm. The EL from the blends exhibits new emission features between 500 nm and 600 nm, which are not present in either the Bu-PPyV or the PVK. When the content of Bu-PPyV in the blend is high, the new feature is detectable but weak in comparison with the EL features characteristic of pure Bu-PPyV. As the content of Bu-PPyV decreases, the new feature dominates the emission and gradually shifts to the blue until it reaches about 500 nm. The origin of the new feature was identified by comparing it with the concentration-dependent luminescence of Bu-PPyV in organic solvents. The orange-red emission in pure Bu-PPyV corresponds to emission from Bu-PPyV excimers. The new feature in the blends with low Bu-PPyV content is then thought to be from isolated Bu-PPyV chromophores in the PVK-rich environment, accounting for its large blue shift. In addition to the emission color, the EL efficiency of the LEDs made from the blends are also found to have a dependence on the content of the Bu-PPyV in the blend. The data shows that the new emissive species has higher radiative efficiency than the excimers. It may be due to the localization of excitons on isolated Bu-PPyV chromophores by the wide band-gap PVK, which would cause a lower probability for migration of excitons to quenching sites.

The incorporation of the PVK into the blend also changes the electrical properties of the thin film. To reach the same level of current, pure Bu-PPyV requires an electric field two times higher than that required in PVK. The blends lie between these two limits, with those having higher Bu-PPyV contents requiring a higher electric field. Therefore the excellent hole transport properties of the PVK improve the carrier injection into the blend, reducing the voltage needed to operate the device.

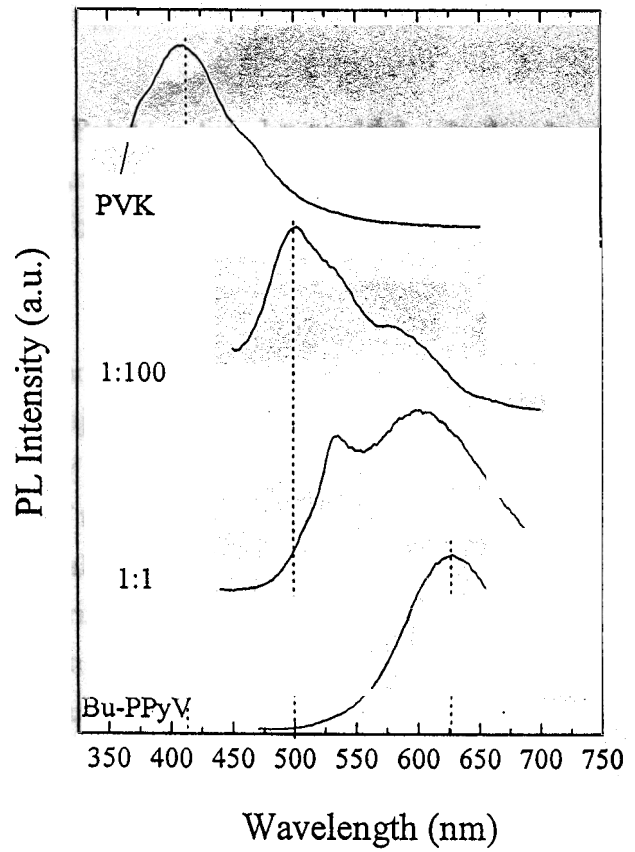
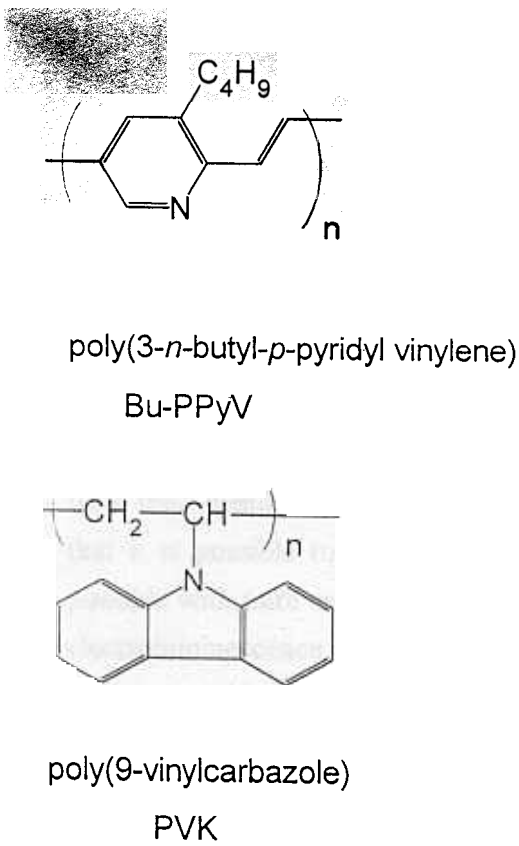


Fig. 2 The photoluminescence spectra of the Bu-PPyV, PVK and Bu-PPyV:PVK (wt:wt) blends.

Fig. 1 The chemical structures of Bu-PPyV and PVK.

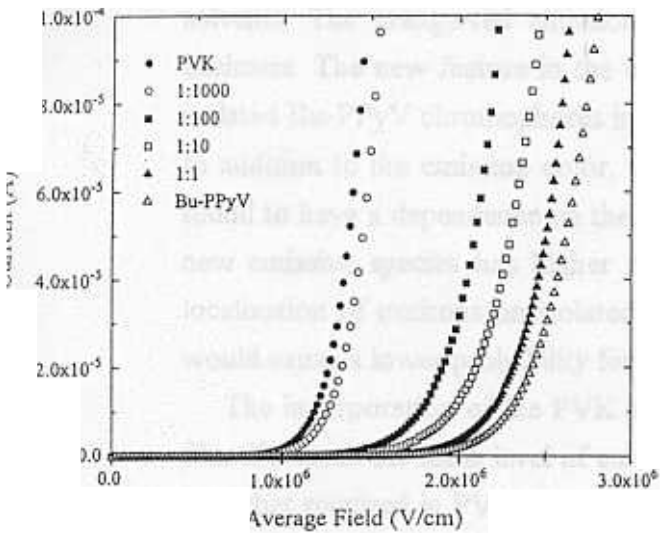


Fig. 3 The current vs. the average electric field characteristics of the LEDs made from the Bu-PPyV:PVK (wt:wt) blends.

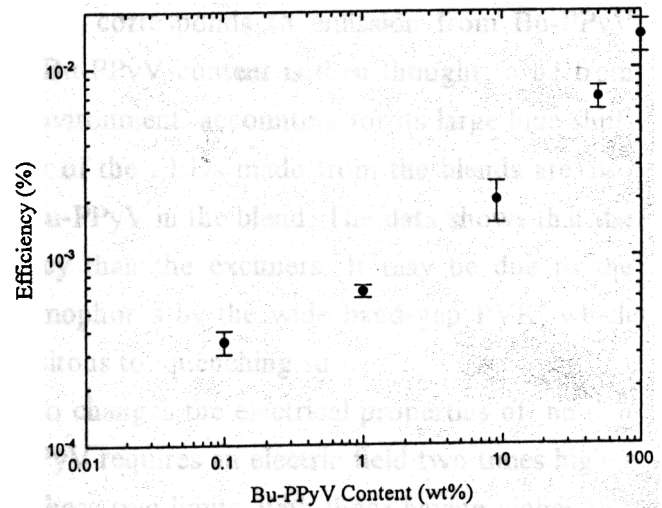


Fig. 4 EL efficiency vs. content of Bu-PPyV in blends