

Photodegradation of the Hole Transporting Layer by Synchrotron Radiation

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Abstract – Degradation studies of the N,N'-bis-(1-naphthyl)-N,N'-diphenyl-1,1'-biphenyl-4,4'-diamine thin films have been performed using synchrotron radiation in order to elucidate the modification of the electronic structure in such organic compound, when nonmonochromatized light was used to simulate the degradation caused by intense sunlight. Core level photoabsorption at the N 1s-edge and valence level photoemission measurements suggest stronger structural stability and a minor loss in the hole transporting properties.

The increase of operational lifetime for Organic Light-Emitting Diodes has stimulated many studies focused on the mechanisms responsible for their degradation. Degradation studies of the N,N'-bis-(1-naphthyl)-N,N'-diphenyl-1,1'-biphenyl-4,4'-diamine thin films have been performed using synchrotron radiation in order to elucidate the modification of the electronic structure in such organic compound, when nonmonochromatized light was used to simulate the degradation caused by intense sunlight. Intensive investigations on OLEDs have been motivated by the eagerness to develop display and lighting devices with low energy consumption for both electronic and optoelectronic devices such as the organic lightemitting transistor architectures [1, 2]. The NPB film was deposited on substrate of Indium-Tin-Oxide (ITO) coated glass, where the NPB was successively thermally evaporated onto ITO at room temperature from tungsten crucibles. The ultraviolet photoelectron spectroscopy (UPS) and Near Edge X-ray Absorption Fine Structure (NEXAFS) measurements were carried out at TGM (Toroidal Grating Monochromator; 12 – 300 eV) and SGM (Spherical Grating Monochromator; 270 – 1000 eV) Beamline of the Brazilian Synchrotron Light Source (LNLS) in Campinas, Brazil. Figure 1 shows the NPB spectra degraded for different times, when it is observed basically, a similar structure in relation the original spectra. Peak a contains contribution mainly of the Benzene and Biphenyl rings, whereas peak c presents mainly contribution from Naphthalene. Peak b has contribution of all constituent molecules. Nevertheless, the peaks present a correspondence in their spectral structures when compared to the non-degraded spectrum, showing a larger molecular structural stability as observed in Fig.1. Figure 2 shows a decrease in the structure due to π^* state, when these changes are associated at loss of OLED luminescence due to break C-N bond, this beak bond is attributed to the N- Benzene and Naphthalene groups. This produces a loss of charge mobility of the NPB molecule upon loss benzene rings.

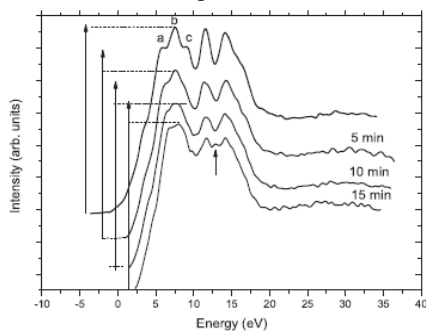


Figure 1: UPS spectra of NPB film for increasing irradiation time with non-monochromatized light.

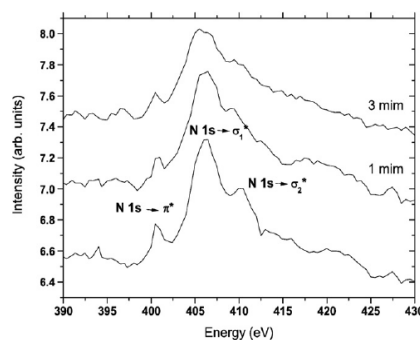


Figure 2: NEXAFS spectra of NPB film for increasing irradiation time with non-monochromatized light.

[1] C. Adachi et al., Appl. Phys. Lett 57 (1990) 531.
[2] A. Hepp et al, Phys. Rev. Lett 91 (2003) 157406.