Appendix B. Double-layer Devices with PMMA-adulterated TPBI as the Electron-transporting Layer at the Cathode

In this appendix we show that device efficiency can be greatly ameliorated by spin coating the hole-transporting layer, which is a blend of PMMA and TPBI with Chlorobenzene as the solvent. PMMA is an insulting material. Its chemical structure is shown is Figure B.1. PMMA here plays a role of providing a matrix for TPBI to form a smooth film, because it is almost impossible for a small molecule such as TPBI to form a good film alone for the spin coating process.

Before actually spin coating the two-ingredient blend and using it as the hole-blocking layer, we have to find the best blending ratio between them. The definition of "best blending ratio" means that the blend contains enough PMMA so that TPBI can be braced and the blend can form a good film. On the contrary, however, exceeding amount of PMMA in the blend makes the blend nonconducting. Therefore we first measure the electron current of devices with various blending ratios. Since TPBI has a high IP level (about 6.7 eV), we can produce devices of the structure PEDOT/TPBI:PMMA/LiF/Ca/Al. Because PEDOT has an IP level of 5.2 eV, there is a large hole barrier at the anode side. Thus there is scare hole current in this structure. Furthermore, for the sake of making sure that there are no particulates on the surface of film

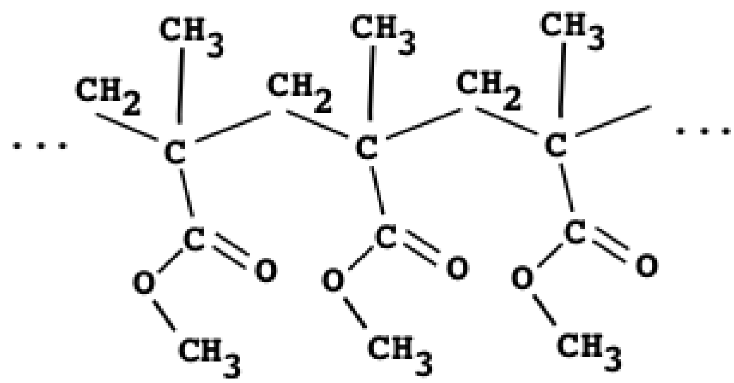

Figure B.1: The chemical structure of Poly(methyl methacrylate) (PMMA).

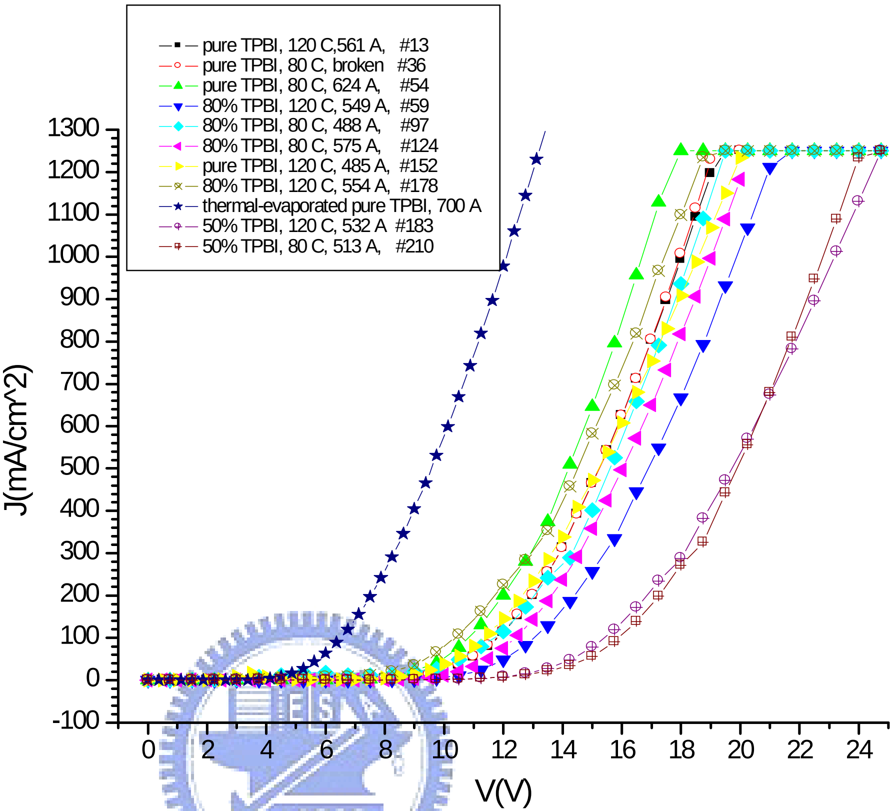

Figure B.2: Electron current density of various blending ratios of TPBI-PMMA.

after baking, we tried different baking temperature. Fortunately there were no particulates under both baking temperatures of 120°C and 80°C. Figure B.2 shows the J-V diagram for electron-only devices with several blending ratios. We also produced a purely thermal-evporated TPBI device, denoted by ★, to compare with other spin-coating ones.

We may observe that the best production condition for the blending layer is the ratio of $TPBI : PMMA = 80 : 20$ and baking temperature of 80°C. Next we use this to produce the double-layer device with the structure of PEDOT/PFO/TPBI/LiF/Ca/Al. We compare single-layer devices (devices without the TPBI layer) with double-layer ones, and find that the performance of luminous efficiency of the latter increases at least twice and luminance of the latter improves ten times greater than the former. Also we find that the spectra of both remain almost the same. Results are shown in Figure B.3.

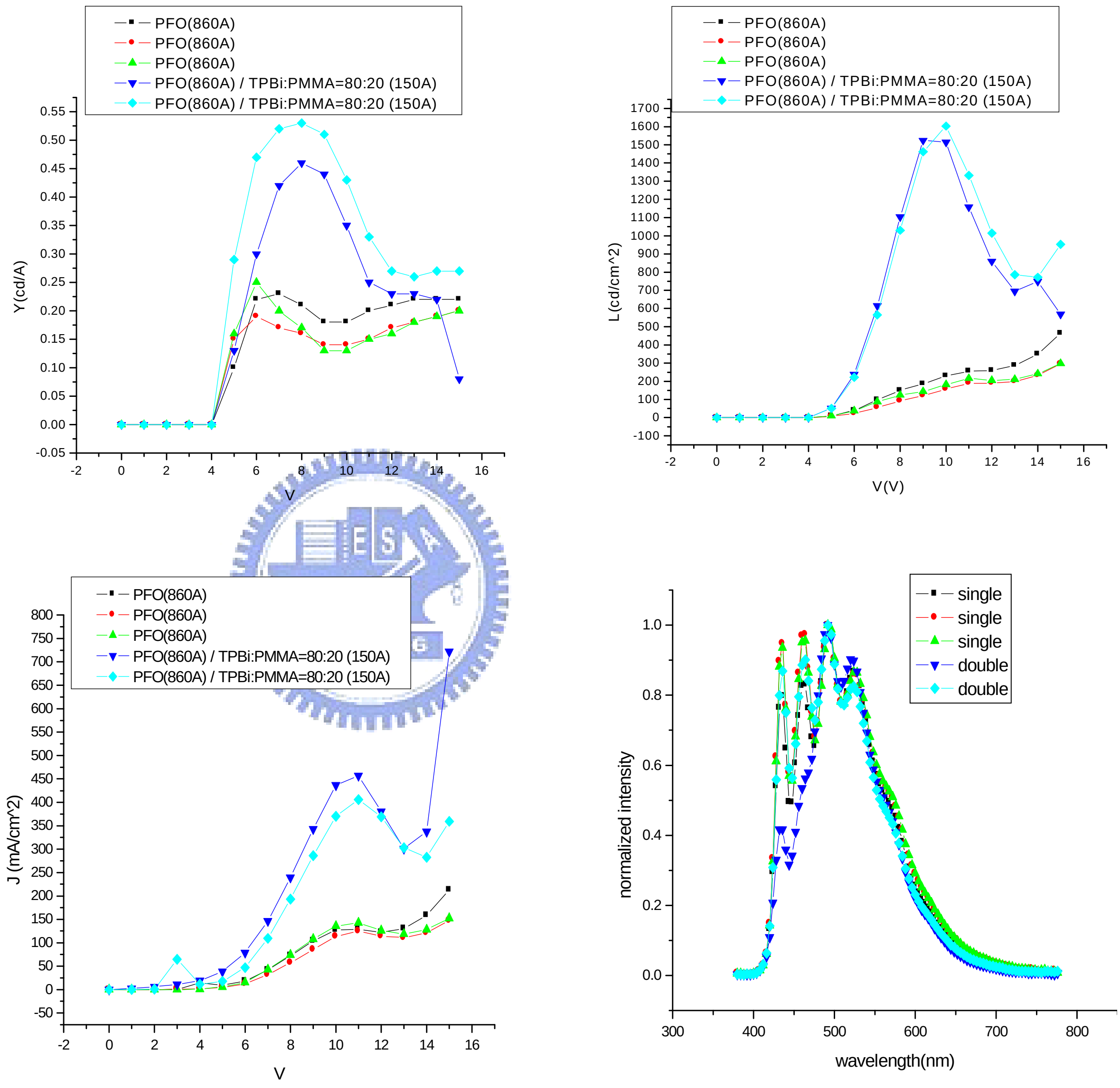

Figure B.3: Improving the device performance by using the TPBI-PMMA blend as the electron-transporting layer.