Investigation of effects of anode buffer layer for organic light emitting devices by admittance spectroscopy

Ming-Chi Li[*], **Hui-Ling Weng**[*], **Sheng-Yuan Chu**[*,**]

**Department of Electrical Engineering, National Cheng Kung University, Tainan 70101, Taiwan*

*Phone: +886(6)275-7575 ext.62381 ** E-mail: chusy@mail.ncku.edu.tw*

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Recent years, organic light-emitting diodes (OLEDs) have drawn considerable attention because of their advantages, e.g., fast response, low cost, and flexibility. However, there is still much room for further optimization[1]. To enhance the OLEDs performances, charge carriers injection balance is a major issue. We use MoO_3 as hole injection buffer layer in this study because of its HOMO[2] is suit to structure. MoO_3 provides a stair-like HOMO level(Fig. 1), which can reduce energy barrier and improve the injection of hole carriers.

In this study, a series OLEDs of structure ITO/MoO_3(0-6nm)/CBP/TPBi/LiF/Al and hole-only devices(HOD) ITO/MoO_3/CBP/Al were fabricated by vacuum vapor deposition at a pressure of 1 x 10^{-6} Torr to investigate the MoO_3 buffer effect. The L-V curve shown as Fig. 2 figures out the 4-nm-thick MoO_3 films has the best performance. Admittance Spectroscopy Measurement (ASM) is a powerful tool which can investigate the electric circuit parameters. The hole-only device could be regarded as a RC equivalent circuit[3] and analyzed by ASM, as shown in Fig. 3 where C1 represents a whole device capacitance, R1 is resistance seen as open circuit because of the CBP's high impedance characteristics. As shown in Fig. 4, whether MoO_3 buffer layer exists, the geometric capacitance is still changeless, so we could ignore the resistance of MoO_3. However, the MoO_3 buffer layer can affect the heterojunction between the electrode and semiconductor. The influence reacts on the series resistance Rs. By using the formula $\omega = (RC)^{-1}$ and the conductance frequency response shown in Fig. 5. The actual series resistance can be counted finally.(displayed in Table. 1).

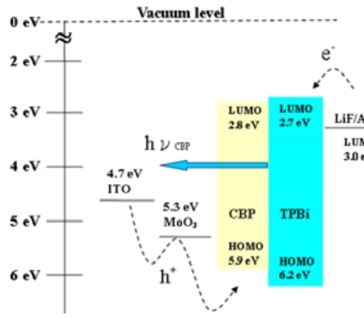

Fig. 1 Energy level diagram

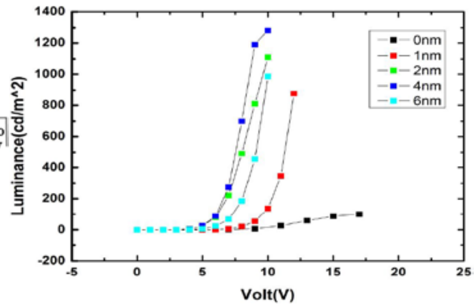

Fig. 2 L-V curve of OLEDs

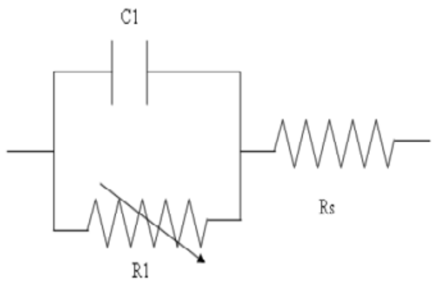

Fig. 3 Equivalent electric circuit

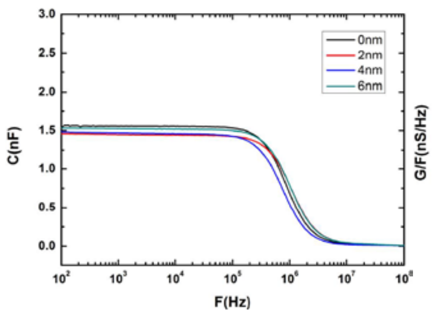

Fig. 4 HOD C-F curve

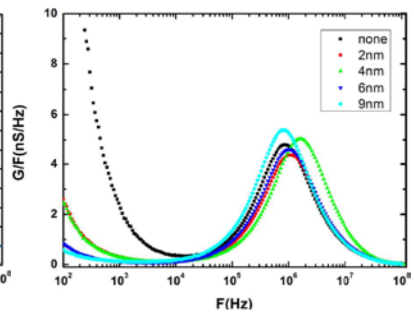

Fig. 5 HOD G/F-F curve

MoO_3 thick	Rs
0 nm	725Ω
2 nm	687Ω
4 nm	346Ω
6 nm	491Ω
9 nm	687Ω

Table 1 Series resistance

In summary, the improvement of device performance can be obtained after inserting the injection buffer layer. We could also know that the best thickness of buffer layer has the lowest series resistance which means more carriers injection by applying ASM. Following this concept, we could predict the suitable material thickness, reducing the experimental cost and research time.

References

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