CHAPTER 7

CONCLUSION AND SUGGESTION FOR FUTURE STUDY

7.1 Conclusion

This thesis has addressed three major topics related to Alq_3-based organic light emitting diode (OLED): single layer OLED made with robust preparation method, improvement of performance of the single layer OLED via simple doping method and effects to the doped single layer OLED annealing process.

Single layer OLED based on Alq_3 has been deposited using a simple spin coating method using chloroform as the solvent. The fabrication and characterization of the device was performed in an ambient air environment. The UV-Vis absorption and photoluminescence (PL) results show an identical of Alq_3 absorption and green luminescence spectrum, respectively, which concludes that the optical properties of the Alq_3 in the thin film form do not depend on the preparation and characterization condition. However, from the electroluminescence characterization, it is deduced that the electrical and luminescence properties of the device are strongly dependence on the fabrication and characterization conditions and environments.

A novel organic blend of emissive layer, TPD:PBD:Alq_3 blend, has been introduced as a way to enhance the performance of the single layer OLED. The optical absorption spectrum shows an absorption spectrum of each element in the blend system which indicates that no interaction occurs among those molecules in such a blend system. The PL spectrum shows an exact green spectrum of Alq_3 with no shifting property. Therefore it can be concluded that the Alq_3 plays an important role as the centre of luminance in the blend system. The performance of TPD:PBD:Alq_3 OLED shows a significant increase as compared to that of pure Alq_3 OLED.

Balance accumulation of holes and electrons in the emissive region of the OLED is the important key of the enhancement of performance of the OLED device. In this novel system, PBD plays significant role to enhance electron transporting in the TPD:Alq_3 OLED system. Even the Alq_3 itself is an electron transporting material, the configuration of the hole only OLED device cause the Alq_3 most likely becomes a centre of emission. Based on OLED configuration and existence of TPD, hole accumulation is more dominant than electron. By doping with TPD:Alq_3 blend with PBD molecule, the charge carrier accumulation becomes more balance and the radiative recombination is increase significantly.

The optimum performance of the single layer blend OLED was obtained for device annealed at temperature 100^{o}C for 10 minutes. The maximum luminance is doubled as compared to the as-cast device. It also indicates that, above 10 minutes of annealing time, the OLED device starts to degrade and result in significant reduction in the performance of the device. This optimum annealing condition can be a good guideline for an open-air annealing process.

7.2 Future work

A lot of efforts have been focused on the investigation of single layer OLED devices based on blend system. Adapting a blend system is a robust way of improving the performance of the OLED devices. The blend system has several advantages over a multilayer OLED system. Compared to a multilayer system, the blend system allows OLEDs to be prepared by using simple solution processing methods such as a spin coating, and ink-jet printing for large area fabrication. In a blend system, an OLED is fabricated as a single layer device which simplifies the design architecture and processing method of the device, as opposed to a multilayer OLED which can be quite complex. By varying the compound and ratio of the blend system, the properties of OLEDs can be optimized such as colour variation, operation voltage and efficiency. In order to achieve better device performance, further investigation on the OLED based on blend system is required.

There are several suggestions that can be used in future work related to this thesis. It is fundamentally understood that the PBD and TPD dopants promote a balance carrier accumulation inside the blend film. However, the ratio of the elements in the blend is fixed to 1:1:1. Thus, it is interesting to investigate the effects of the blend ratio on the performance of the blend OLED device. The luminance of the device might be different for different dopants ratio as the energy transfer could depends on the dominant dopant concentration. Moreover, the efficiency of the device may probably increase significantly for a particular blend ratio.

Even though the highest maximum luminance and efficiency have been achieved, the annealing condition such as temperature, time and environment can be varied to further optimize the blend OLED device. Thermal stability analysis can be performed to obtain the exact glass transition temperature, T_g, of the blend for proper annealing process. The annealing temperature can be selected from lower to higher up to or near the T_g. The duration of annealing process can be increased further above an hour. The annealing can be performed in various environments such as in vacuum or in an ambient inner gas.

Degradation is one of the main issues in OLED production. Thus a study on degradation can be performed to optimize the lifetime of the device. For this purpose, encapsulation is an important process to reduce the degradation effect. It is also interesting to investigate the effects of storage conditions on the lifetime of the device. In particular, comparison can be made for device that is exposed to air (either with or without encapsulation) with the device that is kept in vacuum or inert gas condition. The stability in the operation process of the device is needed for the device production and commerciality.