Co-Deposition of Rubrene doped Alq3 film Using Belt Source Evaporation Techniques for Large Size AMOLED

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Abstract

The belt source evaporation is for the large size AMOLED devices to re-sublimate the organic film deposited on the metal plate. Using the plane source, the PL spectrum of the doped organic film has been studied for the first time. The PL peak of the pure Alq3 film was 512nm and that of the pure Rubrene was 557nm. The PL peak of the 2% Rubrene doped Alq3 film was shifted to 536 ±2nm. The PL peak wavelength measured at the front surface of the film and at the back surface of the film was measured as nearly same as that the doping ratio maintains uniform within the film thickness. In conclusion, the doping control of the organic film becomes real using the belt type plate sublimation deposition.

1. Introduction

In order to realize the high productivity of the large size AMOLED devices, the organic evaporation technology for the large size organic film needs to be critically developed. Regarding this issue, the belt source evaporation technique has been developed as new concept of vacuum thermal evaporation as shown in figure 1.[1]

The organic molecules evaporating from the LPS sources [2] are deposited on the lower area of the belt plate during moving. Then, the deposited metal belt transfers to the substrate and warm up to re-evaporated the organic vapor toward the substrate at the bottom. This procedure is often called as “Top-down deposition”.

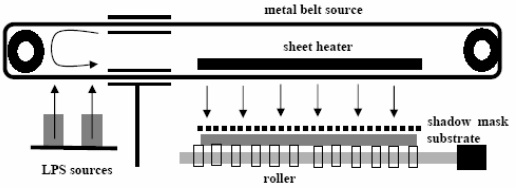

Fig. 1. Belt source evaporation

This process gives high film uniformity (2%) and high material utilization (60% ~ 80%) for the large size substrate and the high speed deposition process can be realized. Particularly, because the substrate is transferring via a roller, the large size substrate will not have any bending trouble as in conventional system and it brings us simple structure in a deposition chamber for pattering organic films without a substrate chuck and a mask chuck assemblies.[3]

In this report, the Alq3 and Rubrene were co-deposited on Ta plate to re-sublimate by fast heating operation and the PL spectrum of the Alq3 film doped with Rubrene will be discussed to see a red shift and the doping uniformity using the plan source sublimation technology.

2. Experiments

As shown in figure 2, the Alq3 and Rubrene powders filled each in two LPS sources evaporates to co-deposit on Ta (Tantalum) metal plate. The Ta plate was 0.1mm in thickness and its size was 100mmX100mm. The distance between the LPS source and the metal plate was fixed at 200mm. The sheet heater has been connected to a temperature

controller and the heating speed of the metal plate was then adjusted.

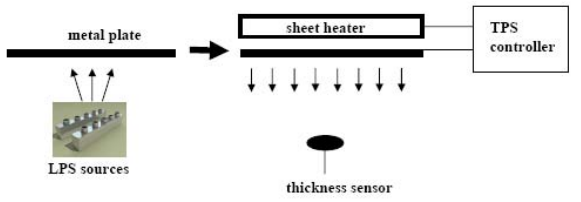

Fig. 2. Plane sublimation experiment

The sheet heater consists of Ta wires to "radiatively" warm up the metal plate and the heating temperature was measured at the center of the metal plate. The heating speed was then programmed in a TPS (Temperature Programmed Sublimation) controller and the thickness sensor was located at the 100mm lower center of the metal plate to measure the downward sublimation signals of the organic films.[4]

3. Results and Discussion

-Alq3

1)Fast heating sublimation of Alq3 film

The 200 Å thickness of Alq3 film has been deposited on the metal plate to re-sublimate at the "fast heating" speed of 9.0℃/s. The sublimation signal is shown in figure 3. The sublimation peak rate is 7 Å/s at the "reading temperature" of 50℃ of the metal surface. (Actually, the metal temperature is 130℃.) Note that the temperature data was recorded slower than the sublimation data by the slow electrical signal response.

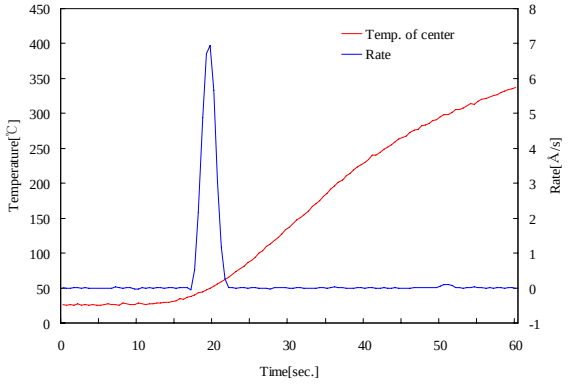

Fig. 3. Fast sublimation of Alq3 film

2)Slow heating sublimation of Alq3 film[5]

The 200 Å thickness of Alq3 has been deposited on the metal plate to re-sublimate at the "slow heating" speed of 0.1℃/s. The sublimation signal is shown in figure 4. The sublimation peak rate is 0.25 Å/s at the temperature of 130℃ of the metal surface.

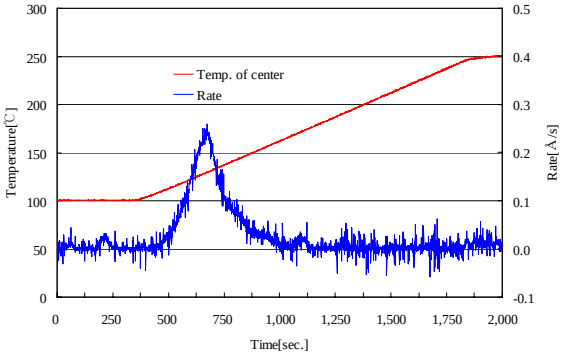

Fig. 4. Slow sublimation of Alq3 film

3)PL spectrum of Alq3 film

The 100 Å thickness of Alq3 film has been deposited on a glass substrate by fast heat operation of the metal plane. The PL spectrum was shown in figure 5 to provide the peak wavelength as 512nm.

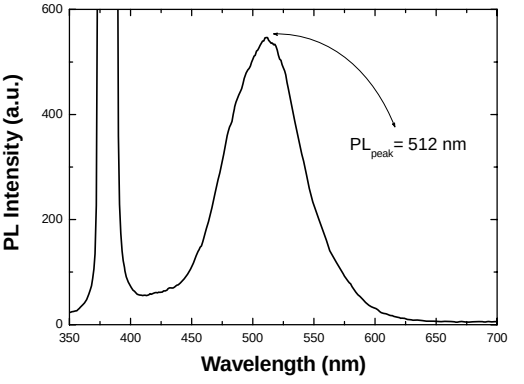

Fig. 5. PL spectrum of Alq3 film

-Rubrene

1)Fast heating sublimation of Rubrene film

The 200 Å thickness of Rubrene film has been deposited on the metal plate to re-sublimate at the "fast heating" speed of 9.0℃/s. The sublimation signal is shown in figure 6. The sublimation peak rate is 7 Å/s at the "reading temperature" of 45℃ of the metal surface. (Actually, the metal temperature is 98℃.)

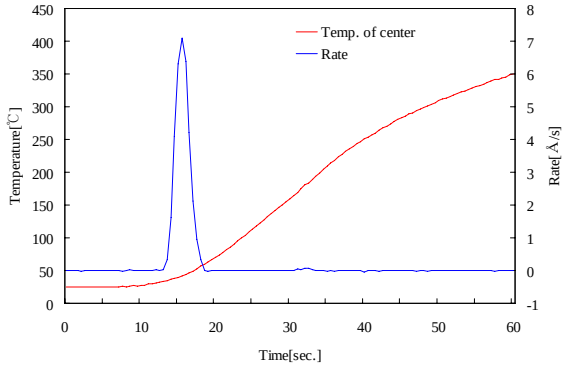

Fig. 6. Fast sublimation of Rubrene film

2) Slow heating sublimation of Rubrene film

The 200 Å thickness of Rubrene has been deposited on the metal plate to re-sublimate at the "slow heating" speed of 0.1℃/s. The sublimation signal is shown in figure 7. The sublimation peak rate is 0.1 Å/s at the temperature of 98℃ of the metal surface.

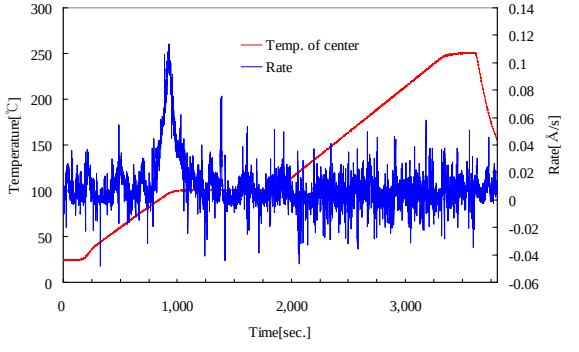

Fig. 7. Slow sublimation of Rubrene film

3)PL spectrum of Rubrene film

The 100 Å thickness of Rubrene film has been deposited on a glass substrate by fast heat operation of the metal plane. The PL spectrum is shown in figure 8 to provide the peak wavelength as 557nm.

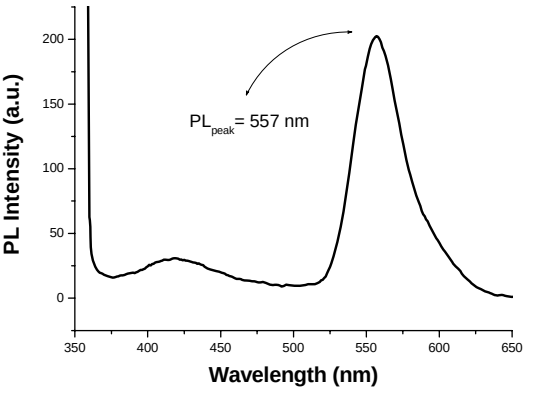

Fig. 8. PL spectrum of Rubrene film

-Alq3+2%Rubrene

The Alq3 vapor and Rubrene vapor were co-deposited to a metal plate at the rate of 5 Å/s and 0.1 Å/s, respectively and the thickness of the film was 200 Å on the metal plate. The 100 Å thickness of 2% Rubrene doped Alq3 film has been then deposited on a glass substrate by fast heat operation of the metal plane. The PL spectrum at the front surface of the film is shown in figure 9 to provide the peak wavelength as 536 ±2nm.

The PL peak of Alq3 film was 512nm and the PL peak of the 2% Rubrene doped Alq3 film was red shifted by 24nm. From this, it is proved that the plane sublimation technique becomes true for the doping control.

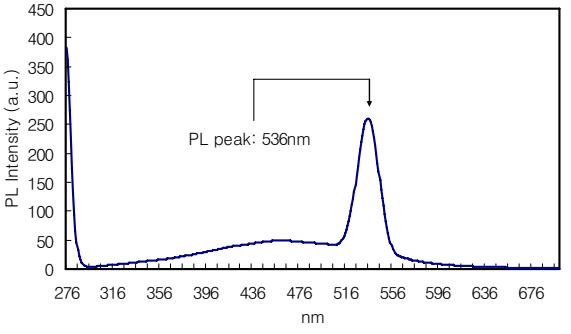

Fig. 9. PL spectrum for Alq3+2%Rubrene (Front)

The PL spectrum at the back surface of the film is shown in figure 10 to provide the peak wavelength as 532 ±2nm. The emission light was then collected through the glass so that the PL intensity becomes 6 times less than that of the front surface. (Peak intensity of the front surface is 261 and peak intensity of the back face is 39.)

From this, the PL peaks at the front and back face were almost same within an error range. In other words, the doping ratio is quite uniform over the film thickness.

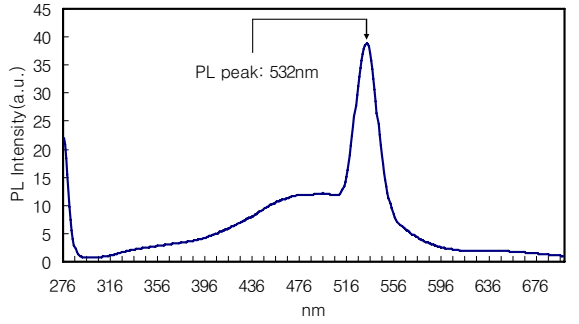

Fig. 10. PL spectrum for Alq3+2%Rubrene (Back)

In summary, the belt source evaporation technique becomes true for the doping control and the co-sublimation of the host and dopant occurs at the metal surface at the fast heating speed (5 ~ 10℃). It provides to co-deposit the host and dopant on the glass substrate. The doping ratio maintains as same as the multiple sublimation occurs. [5]

-Alq3+3%Rubrene

The Alq3 vapor and Rubrene vapor were co-deposited to a metal plate at the rate of 5 Å/s and 0.15 Å/s, respectively and the thickness of the film was 200 Å on the metal plate. The 100 Å thickness of 3% Rubrene doped Alq3 film has been then deposited on a glass substrate by fast heat operation of the metal plane. The PL spectrum is shown in figure 11 to provide the peak wavelength as 556nm.

The PL peak of Alq3 film was 512nm and the PL peak of the 3% Rubrene doped Alq3 film was red shifted by 44nm.

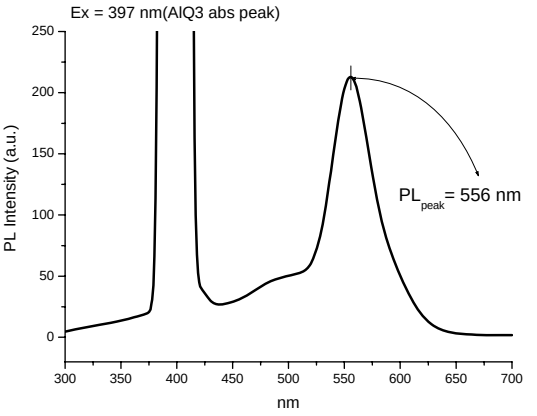

Fig. 11. PL spectrum for Alq3+3%Rubrene

4. Conclusion

Using the plane source, the PL spectrum of the doped organic film has been studied for the first time. The PL peak of the pure Alq3 film was 512nm and that of the pure Rubrene was 557nm. The PL peak of the 2% Rubrene doped Alq3 film was shifted to 536 ±2nm. The PL peak wavelength measured at the front surface of the film and at back surface of the film was measured as nearly same as that the doping ratio maintains uniform within the film thickness. In conclusion, the doping control of the organic film becomes realistic using the belt type plate sublimation deposition.

5. References

[1] C.H. Hwang, plane source and inline type manufacturing system for large scale AMOLED, SID06, vol. 47.3(2006)

[2] C.H. Hwang, YK Kim, KH Shin, SH Ju, JH Kwon, Belt source and in-line manufacturing equipment for very large-size AMOLED, IMID, P1403(2006)

[3] C.H. Hwang, YK Kim, KH Shin, SH Ju, JH Kwon, Study of metal plate evaporation using LPS source for AMOLED, IMID, P1385(2006)

[4] C. H. Hwang, New TPS function for identifying nano scale film phase using belt source evaporation techniques, SID2007, P53(2007)

[5] C. H. Hwang, Doping control of belt source evaporation techniques, IMID2007, submitted(2007)