TPS Analysis of Various Metal Plates for Belt Source Evaporation in AMOLED Manufacturing

Chang Hun Hwang
OLEDON Co., Ltd., Kyunggi-do, South Korea
Phone: 011-1714-9523, Email:chriss_hwang@oledon.com

Abstract

The TPS (Temperature Programmed Sublimation) technology has been developed to monitor the plane evaporation of the organic films and introduced in SID2007, P53.[4] The Alq3 organic film is deposited on various metal surface such as Cu, Ti, Invar, STS to sublimate. The TPS signal confirms that the Alq3 film consists of nano scale film phase and bulk phase on all the metal plates. The sublimation temperature of the Alq3 film was much lower (130 ℃) than the vapor temperature (265 ℃) of the Alq3 powder.

1. Introduction

The OLED (Organic Light Emitted Device) industry meets its transition time from PMOLED to AMOLED. In order to role for the AMOLED technology as post-TFT LCD devices, the most important factor is the highest productivity in manufacturing industry. In particular, it is necessary for the manufacturing equipment for large-size AMOLED and high organic material utilization to be developed so that the AMOLED regards as the next generation display. [1,2]

To realize the high productivity of the AMOLED devices, the organic evaporation technology for the large size organic film, as a main process technology, needs to be critically developed. Regarding this issue, the belt source evaporation technique has been proposed to develop as new concept of vacuum thermal evaporation as shown in figure 1.[1] The belt source is a kind of thin metal made plane source.

The organic molecules evaporating from the LPS sources [2] are deposited on the lower area of the belt plate during moving. This procedure is often called as “Top-down deposition”.

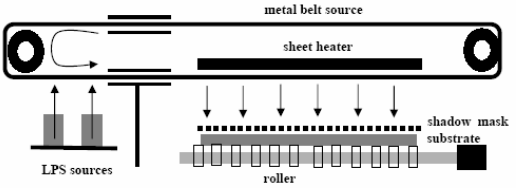

Fig. 1. Belt source evaporation

This process gives high film uniformity (2%) and high material utilization (68%) for the large size substrate and the high speed deposition process can be realized. [3] 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 substrate chuck and shadow mask chuck assemblies.[3]

In addition, the TPS function in belt source evaporation can identify the nano scale organic film phase on a substrate and help us to decide the optimum thickness of the organic layers.[4]

In this thesis, using TPS technology, the plane source evaporation of Alq3 organic film on various metal plates is discussed.

2. Experiments

As shown in figure 2, the Alq3 powder filled in LPS source crucible evaporates to deposit on various metal plate such as Cu, Ti, Invar, STS. The metal plate was 0.1mm in thickness and its size was 100mmX100mm. The distance between the LPS

source and the metal plate was fixed at 100mm. The sheet heater has been connected to a temperature controller and the heating speed of the metal plate was then adjusted as 0.1℃/s.

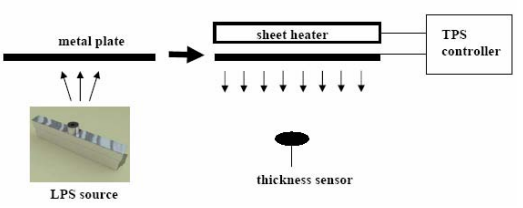

Fig. 2. TPS experiment

The sheet heater consists of Ta wires to "radiatively" warm up the metal plate and the heating temperature was measured at the center and side of the metal plate. The heating speed was then programmed in a TPS 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. The distance between the metal plate and the sensor was fixed at 100mm.

3. Results & Discussion

3-1 Copper

The sublimation signal of the Alq3 organic film with 400 Å thickness was obtained as shown in figure 3. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 0.6 Å/s at the 140℃ of the heating temperature.

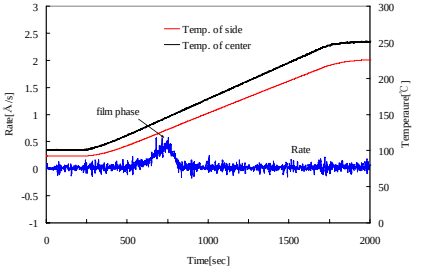

Fig. 3. TPS signal for 400 Å

The sublimation signal of the Alq3 organic film with 800 Å thickness was obtained as shown in figure 4. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 0.8 Å/s at the 150℃ of the heating temperature and 0.2 Å/s at 170℃ for the bulk phase.

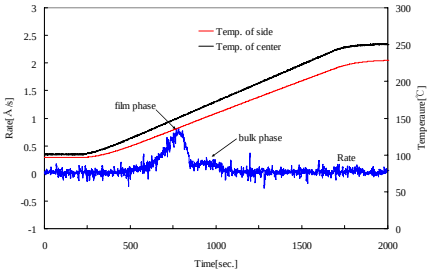

Fig. 4. TPS signal for 800 Å

The sublimation signal of the Alq3 organic film with 8000 Å thickness was obtained as shown in figure 5. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 4.3 Å/s at the 170℃ of the heating temperature and 3.2 Å/s at 190℃ for the bulk phase.

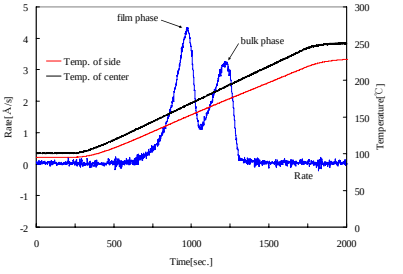

Fig. 5. TPS signal for 8000 Å

3-2 Titanium

The sublimation signal of the Alq3 organic film with 400 Å thickness was obtained as shown in figure 6. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 0.5 Å/s at the 130℃ of the heating temperature.

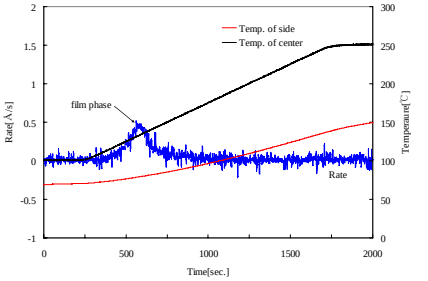

Fig. 6. TPS signal for 400 Å

The sublimation signal of the Alq3 organic film with 800 Å thickness was obtained as shown in figure 7. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 0.8 Å/s at the 140℃ of the heating temperature.

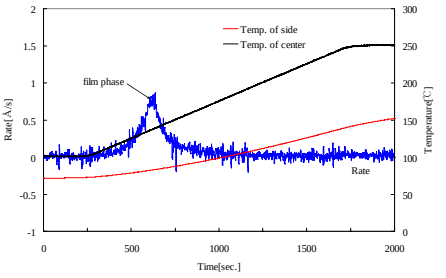

Fig. 7. TPS signal for 800 Å

The sublimation signal of the Alq3 organic film with 8000 Å thickness was obtained as shown in figure 8. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 3.0 Å/s at the 150℃ of the heating temperature and 4.4 Å/s at 180℃ for the bulk phase.

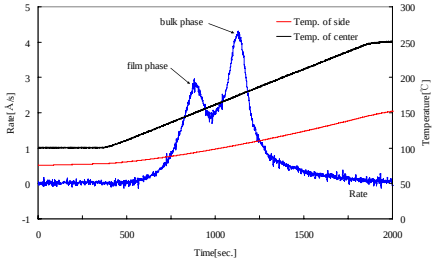

Fig. 8. TPS signal for 8000 Å

3-3 Invar

The sublimation signal of the Alq3 organic film with 400 Å thickness was obtained as shown in figure 9. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 0.5 Å/s at the 140℃ of the heating temperature.

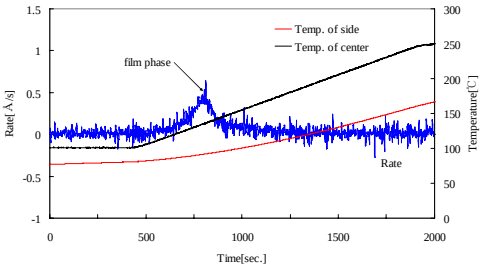

Fig. 9. TPS signal for 400 Å

The sublimation signal of the Alq3 organic film with 800 Å thickness was obtained as shown in figure 10. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 1.0 Å/s at the 145℃ of the heating temperature.

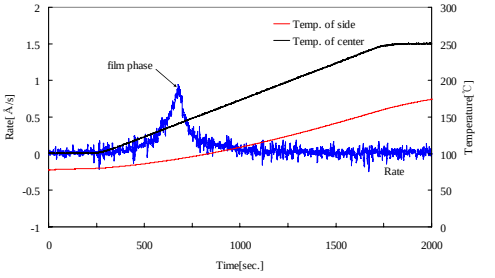

Fig. 10. TPS signal for 800 Å

The sublimation signal of the Alq3 organic film with 8000 Å thickness was obtained as shown in figure 11. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 4.0 Å/s at the 155℃ of the heating temperature and 3.7 Å/s at 180℃ for the bulk phase.

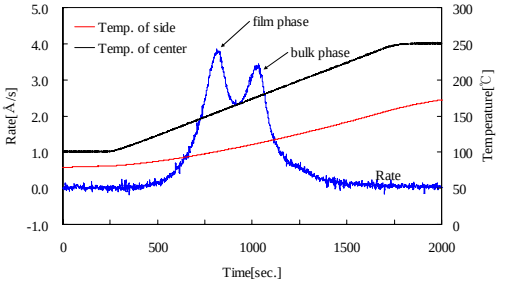

Fig. 11. TPS signal for 8000 Å

3-4 STS304

The sublimation signal of the Alq3 organic film with 400 Å thickness was obtained as shown in figure 12. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 0.45 Å/s at the 140℃ of the heating temperature.

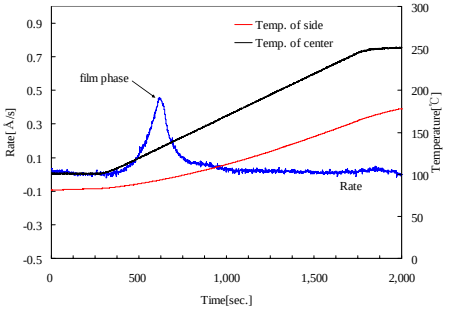

Fig. 12. TPS signal for 400 Å

The sublimation signal of the Alq3 organic film with 800 Å thickness was obtained as shown in figure 13. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 1.0 Å/s at the 150℃ of the heating temperature.

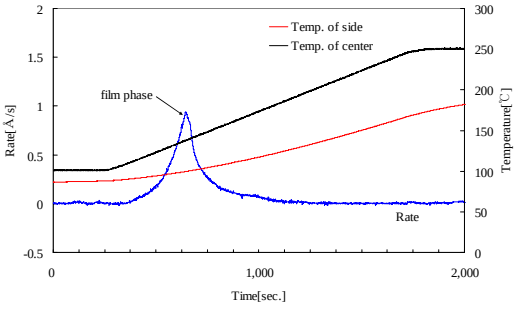

Fig. 13. TPS signal for 800 Å

The sublimation signal of the Alq3 organic film with 8000 Å thickness was obtained as shown in figure 14. The heating speed of the metal plate was 0.1℃/s. The peak rate for the film phase was measured as 2.7 Å/s at the 160℃ of the heating temperature and 3.8 Å/s at 180℃ for the bulk phase.

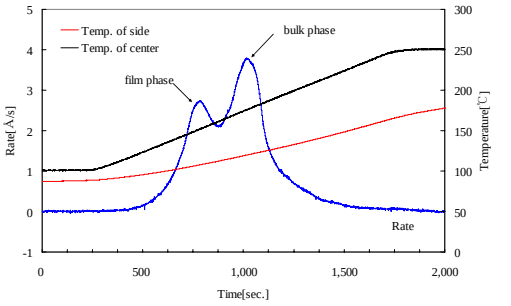

Fig. 14. TPS signal for 8000 Å

4. Conclusion

The Alq3 organic film is deposited on various metal surface such as Cu, Ti, Invar, STS to sublimate. The TPS signal confirms that the Alq3 film consists of nano scale film phase and bulk phase on all the metal plates. The sublimation temperature of the Alq3 film was much lower (130℃~140℃) than the vapor temperature (265℃) of the Alq3 powder no matter what the metal plates is.

6. 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, JID, vol7,No 4(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, et al., New TPS function for identifying nano scale film phase using belt source evaporation techniques, SID2007, P53(2007)