The Latest Improvements in Evaporation System for Mass Production of OLED TV

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Keywords : OLED, Television, Evaporation, Inline, Ellipsometer

Abstract

For OLED to be a key role in the television market, a manufacturing evaporation system with robustness and high throughput is indispensable. ANS is currently developing manufacturing equipments for OLED TVs. ANS's latest progress of a vertical high throughput in-line evaporation system for large substrate will be presented.

1. Introduction

ANS accomplished the progress in the development of small molecular OLED TV manufacturing evaporation system with the size of Gen.5. Main axis of the development is organic deposition process module, metal deposition process module, alignment module, real-time thickness monitoring and control module.

First of all, ANS has developed organic linear nozzle source named 'DSP' for more than 6 years and accomplished great result such as less than 2% of uniformity, around 50% of material usage etc. Currently we improve the convenience and durability for the mass production capability of the evaporation system.

Second, ANS examined various kind of metal deposition concept. But most important points are the reliability and verification of the method. That is to say, we had to focus on the panel damage (by plasma, second electron and heat), robustness, up-time etc. So, we decided thermal evaporation source and we will introduce about the evaporation method.

The last one is the inline real-time thickness monitoring and control module. We always focused on the productivity and up-time ratio. But one of weak point of inline system is inconvenience of the gate inspection during the process. In order to solve that problem, we applied inline type Ellipsometer in our system. With this, we can monitor and control the real thickness of each layer during the production and manage the accident in a short time. We expect that it will help the tremendous progress for the productivity and thickness control accuracy of the system.

2. Experimental

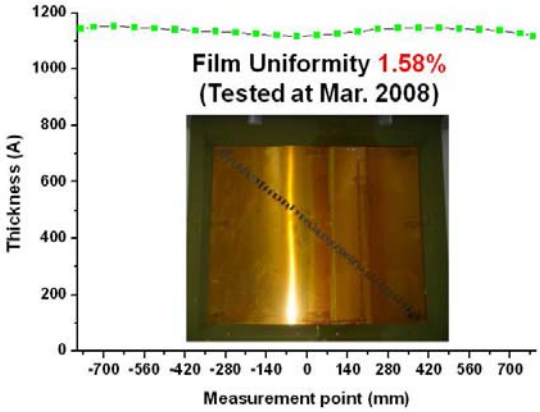
Our target of the OLED TV mass production evaporation system is as below table.

Table.1. Specification summary of mass production evaporation system

Module	Item	Guarantee
Alignment Module	Alignment Accuracy	< ±20 ㎛ (< ±200 ㎛ for Lighting)
Organic Module	Organic Uniformity	< ±2% (< ±3% for Lighting)
	Material Usage	> 50%
	Rate Stability	< ±2%
	Thickness Monitoring	Real-time measurement (by Ellipsometer)
	Thickness Control	Crystal & Ellipsometer feedback system
Metal Module	Metal(Cathode) Uniformity	< ±5%
	Substrate Temperature	< 70℃ (< 90℃ for Lighting)
Total System	Tact Time	< 2mins (Max 1000Å thickness for each layer)
	MTBM (Mean Time Between Maintenance)	> 2 weeks

In order to meet this specification we did various kinds of test, and the results are as below.

First of all, the result of organic material evaporation uniformity is less than ±2% for 25 points of 1100× 1300 ㎟ area diagonal direction. At this test, we used Si wafer for substrate and measured by Ellipsometer.



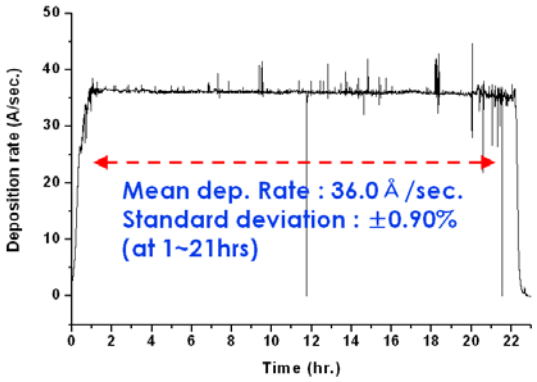
Graph.1. Result of uniformity test at Gen.5 system

In the second place, in order to measure the material usage of the organic evaporation module, we used traditional weight measurement method. We measured the weight of the charged material and substrate first and measured again after deposition. We checked the difference of the charged material and substrate.

Fig.1. Material, substrate and attached substrate

The result was 49%. It includes rate ramp-up and cooling-down time loss also. So, we can say that it is the same real data with mass production condition.

In the third place, in order to check the deposition rate stability, we did long run test for 20 hours. And the result was less than 1% of standard deviation. But we do some more other efforts to improve the stability such as heating structure, sensing method, control software. The next one is one of the major results of our efforts.



Graph.2. Result of rate stability for 20 hours run

In the fourth place, we focused on the thickness monitoring and controlling system and assembled the system as below. Usually crystal sensor and monitor themselves are not accurate enough and measuring and monitoring the thickness outside take so much time. That's why we focused on the real-time measurement and control system.

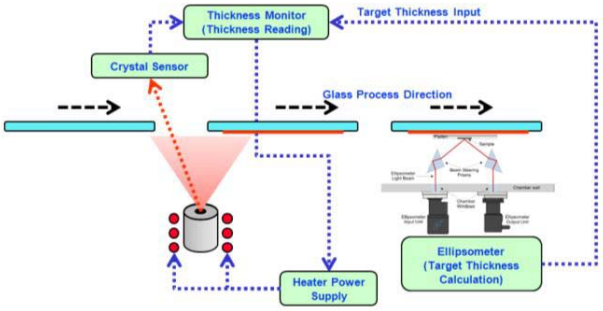


Fig.2. Real-time thickness monitor and control system schematic

But there is a problem. Currently Ellipsometer cannot measure the multiple stack of the film. So, we applied single layer deposition method as below.

This development is coming along very well with famous Ellipsometer maker. And we expect to finish until the first quarter of 2009.

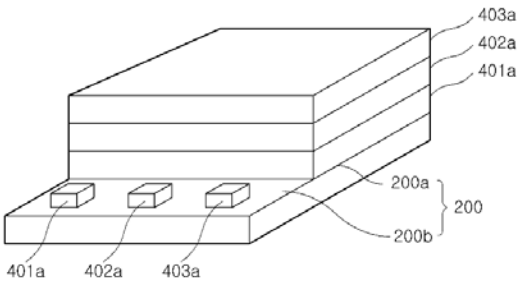


Fig.3. Single layer deposition method

In the fifth place, before achievement of less than ±5% of metal uniformity, the metal deposition method must meet the following conditions. Those are no organic material damage, high deposition rate, long time continuous deposition, and so on. There are not so many options. We cannot use sputter, CVD because of the plasma damage. And we cannot use E-beam also. So, we decided conventional thermal high temperature source with feeder. And in order to use at the vertical inline system, we use the tilted source with thickness compensation shield as below.

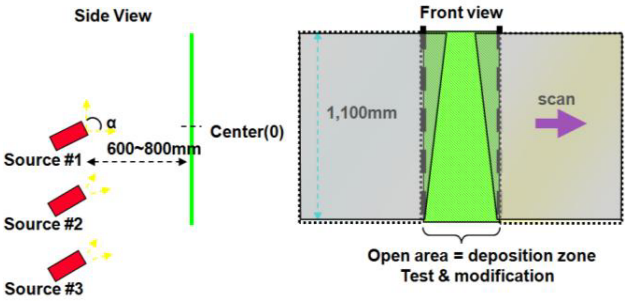
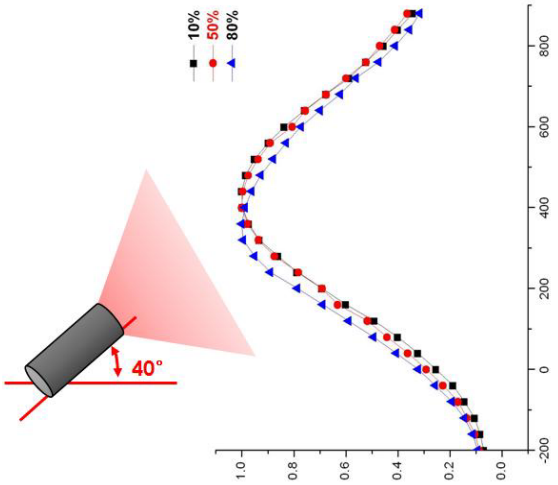


Fig.4. Metal deposition method

We positioned the multi source vertical direction and tilting to the substrate direction and deposit. But uniformity would not be good. Then we modified the compensation shield by using simulation tool. ANS tried test at the Gen.2 test chamber and checked the possibility. The result is as below. At the less than 50% of the charge, the flux is not changing. It means the uniformity also controlled by the compensation shield.



Graph.3. Result of tilted source deposition

3. Results and discussion

According to the result of test, we expect that around 20K/month (2minutes tact time and more than 90% of up-time) throughput Gen.5 mass production evaporation system for OLED TV is possible. This system capability would be necessary for the cost competitiveness.

So, we are under progress of establishing the expanded demonstration system to verify the possibility of the mass production evaporation system until the end of this year. This project includes alignment module, organic process chamber modification, metal process module, inline monitor and control module expanding and verification.