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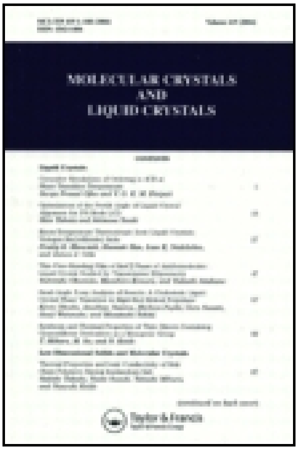

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Anti-Reflective Coating for Improved External Efficiency of Organic Light Emitting Diode

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Anti-Reflective Coating for Improved External Efficiency of Organic Light Emitting Diode

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We coated multi-stacked anti-reflective (AR) layer on the glass substrate before deposition of ITO electrode and then fabricated and tested the OLED device. Through the results, it was experimentally found that the emitting efficiency of the OLED device with multi-stacked anti-reflective layer improved than the OLED device without it.

Consequently, it was revealed that the external emitting efficiency of OLED device can be improved by deposition of the anti-reflective layer between glass substrate and ITO electrode. It was also found that the device can be easily fabricated without vacuum break by employing existing thermal evaporation.

Keywords: CeO; multi-stacked anti-reflective coating; OLED; SiO

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INTRODUCTION

The organic light emitting diode (OLED) which has been commercialized by Pioneer at 1997 has very unique properties such as low consuming power level and high contrast, which makes OLED to be very good candidate display system for next generation [1–4].

Recently, the OLEDs have been widely investigating and various applications have been developed. Among them, the material fields are dramatically advancing with high-end techniques. Especially, improving performance of material is being reported intensively because effectiveness of material decides lifespan of panel and amount of power consumption [1–8]. The efficiency of the OLED panel can be classified into internal and external efficiency. While the internal

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efficiency is affected by features of materials, the external efficiency is influenced by the structure of devices. In this study, the method for improving the external efficiency was investigated [9,10].

EXPERIMENTAL

In this research, CeO, SiO, ITO, organic material and Al thin films were deposited to fabricate the bottom emission OLED by a thermal evaporation system. The anti-reflective multi-layer films were successively deposited on the glass substrate without vacuum break. Table 1 show the structure of anti-reflective layer. The deposited electrodes were patterned by photolithography. O_2 plasma was treated for 3 min to improve the surface roughness of the ITO and emissive efficiency.

The structure of organic layers was composed with 15 nm thick 4,4′,4″-tris[N-(1-naphthyl)-N-phenylamino]-triphenylamine) (2-TNATA) as a hole injection layer, 30 nm thick N,N′-Diphynyl-4 N,N′-bis-(1-naphthalyl),benzidine (-NPD) as a hole transfer layer, 40 nm thick tris(8-hydroxyquinoline)aluminum (Alq3) with 1% coumarine 6 (C6) doped as a emissive layer and 5 nm thick 2,9-Dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP) as a hole blocking layer. The cathode was 10 nm Al. The organic thin films were deposited at the rate of 0.5 Å/sec and the cathode was 2–3 Å/sec.

RESULTS AND DISCUSSION

Emitting light forward generated from inside of device and subsequent contributing to substantial emitting efficiency is one of the most significant rising issues in these days. These kinds of phenomenon were considered in inorganic EL devices and many solutions, such as placing micro lens on the glass substrate or inserting silica-gel layer for emitting forward wave-guided component of light in glass substrate, are proposed in organic EL devices even though those are still in petty steps. As shown in Figure 1(a), the light generated from

TABLE 1 Conditions of Thermal Evaporator

THICKNESS (Å)	180	250	230	610	780
STARTING P. (Torr)	2.0×10^{-5}	2.5×10^{-5}	9.8×10^{-5}	2.5×10^{-5}	9.8×10^{-5}
WORKING P. (Torr)	3.8×10^{-5}	4.5×10^{-5}	3.5×10^{-5}	4.5×10^{-5}	3.5×10^{-5}
O_2GAS TIME (sec.)	0	0	0	0	0
TEMP. (°C)	83	83	83	83	83
RATE (Å/sec)	3.0	4.0	10.0	4.0	10.0
MATERIAL	Sio	CeO	SiO	CeO	SiO

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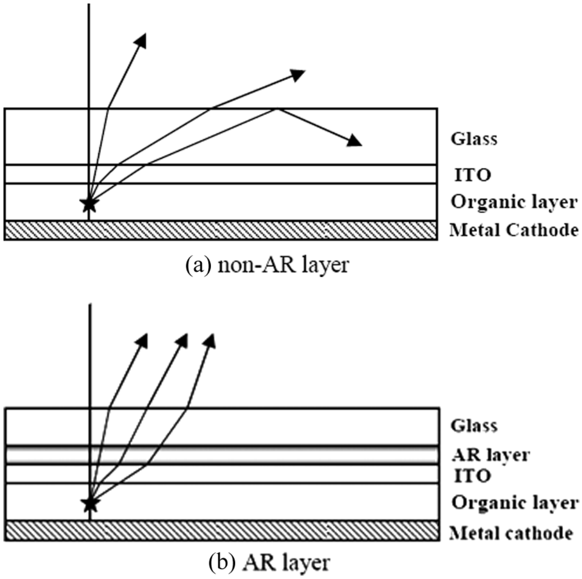

FIGURE 1 Reflectance in OLED device: (a) non-AR layer, (b) AR layer.

organic emitting layer pass through organic layers and ITO-coated glass substrates and is transmitted to the outside. As can be seen in Figure 1(b), multi-stacked anti-reflective layers reduced reflection ray on interface layer.

High level of transmittance was achieved as depicted in Figure 2 by depositing anti-reflective layer between ITO electrode and substrate,

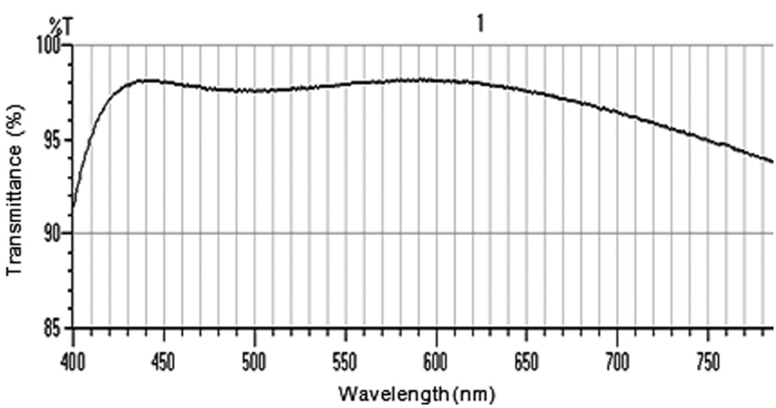

FIGURE 2 Transmittance of anti-reflective layer on glass.

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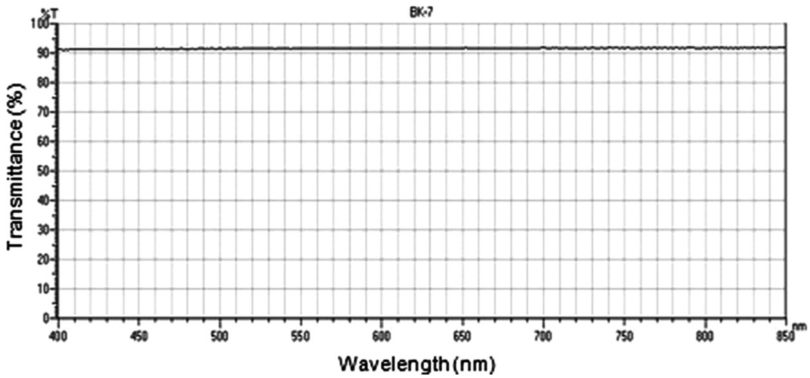

FIGURE 3 Transmittance of non-anti-reflective layer on glass.

compared to those of standard glass as shown in Figure 3. As demonstrated in Figure 4, the emitting efficiency and brightness of the OLED was improved as a result of improved transmittance of substrate by employing anti-reflective layer.

There is no internal efficiency change. ITO work function and organic material are same condition. So demonstrated in Figure 5, the current density of OLED was not changed by employing anti-reflective layer. It was revealed that the external emitting

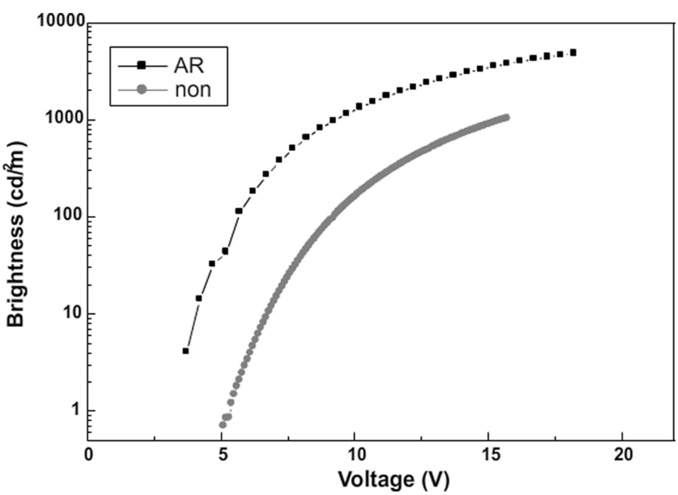

FIGURE 4 Brightness vs voltage characteristics of AR coated OLED and reference device.

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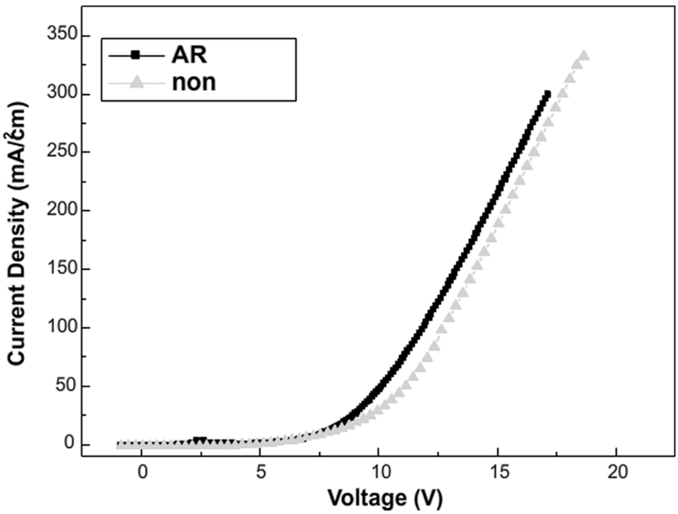

FIGURE 5 Current density vs voltage characteristics of AR coated OLED and reference device.

efficiency of OLED device can be improved by deposition of the anti-reflective layer between glass substrate and ITO electrode. Anti-reflective improve only external-efficiency in OLED devices. But it was also found that the device can be easily fabricated without vacuum break by employing existing thermal evaporation.

CONCLUSIONS

We coated multi-stacked anti-reflective layer on the glass substrate before deposition of ITO electrode and then fabricated and tested the OLED device. Through the results, it was experimentally found that the emitting efficiency of the OLED device with multi-stacked anti-reflective layer improved than the OLED device without it.

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