O130-Enhancement of the light extraction efficiency by using high refractive index glass substrate for OLED lighting

C. Lee, **T. Yanase, T. Murata, K. Choju, H. Yamazaki**

Nippon Electric Glass Co., Ltd. 7-1 Seiran 2-Chome. Otsu, Shiga 520-8639, Japan

clee@neg.co.jp

OLED lighting has been considered as a next generation lighting source with high efficiency. However, compared to the fluorescent lamp, the efficiency of commercial OLED lighting is not high. The main reason for the low efficiency of the OLED lighting is the reflections occurring at the interface of organic layers (nd=1.8-2.0)/glass (nd=1.52) and glass/air, due to the difference of refractive index between each layer. To solve the problems of light reflection, high refractive-index glass substrate for OLED lighting named HX-1 has been developed. HX-1 has the high refractive index(nd 1.63) and superior chemical resistance. Because HX-1 is made by Over Flow Down Draw process, it has also smooth surface required for the glass substrate for OLED. In this report, we demonstrate that OLED lighting efficiency can be improved only by changing from conventional glass substrate to HX-1.

To investigate the relationship between the light-extraction efficiency of the OLED and refractive index of glass substrates, HX-1 and OA-10G (conventional glass substrate) were used. Green phosphorescent OLED to be used with these glass substrates is made as well. OLED structure is as follows; Glass / ITO, 100nm/HIL, 40nm/NPD, 50nm/Ir $(ppy)_3$ + CBP [6%], 30nm/BAlq, 10nm/Alq, 30nm/LiF, 0.8nm/Al, 150nm. The light-extraction efficiency of the OLED devices with out-coupling film or without the film is measured at $0.9mA/cm^2$. The refractive index of out-coupling film is 1.5. Figure 1 shows the luminous efficiency ratio vs. the refractive index of glass without/with film. As shown in Figure 1, without the out-coupling film, the luminous efficiency of HX-1 is 7% higher than that of OA-10G. On the other hand, with the out-coupling film, the luminous efficiency of HX-1 is 24% higher than that of OA-10G. This proves that improvement of luminous efficiency is achieved with HX-1. From the results, it can be seen that out-coupling film is not used, luminous efficiency becomes slightly higher. We speculate that the slight enhancement of luminous efficiency is attributed to the decrease of reflecton due to the refractive index mismatch between organic layers and glass. By using out-coupling film, even though the refractive index mismatch between the glass and film still exists, the trapped light is extracted into air, resulting in greatly improved luminous efficiency. The result shows that improvement of luminous efficiency is successfully achieved by the high refractive index of HX-1. As mentioned above, the refractive index of out-coupling film is not the same as that of HX-1. We consider that the luminous efficiency of OLED could be higher if we used the out-coupling film with the same refractive index as HX-1. In conclusion, we think that HX-1 is capable of improving luminous efficiency and is thus an ideal substrate for high luminous efficiency OLED lighting devices.

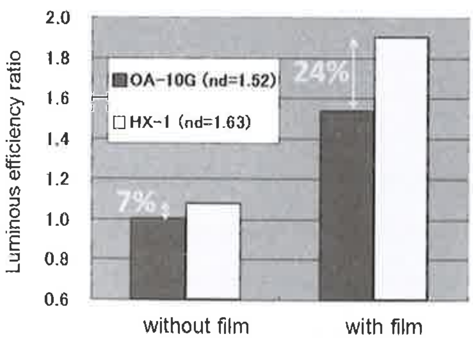

Figure 1. Luminous efficiency ratio versus refractive index (nd) of glass without/with film.