VUV 光照射室温ゾルゲル法による有機/無機多層薄膜の作製と OLED 封止機能評価

Solution processed alternating organic/inorganic multilayer for OLED encapsulation

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Flexible Organic light-emitting diodes (OLEDs) encapsulation is actually one of the major challenges because of chemical instability of the materials against moisture and oxygen being one of the primary reasons to hinder their commercialization. To date, thin film encapsulation (TFE) with a high barrier performance has only been prepared by vacuum-deposition processes (ALD, CVD), the downside is low throughput and high cost due to the technological complexity to limit its use in small size and high-end applications such as displays for smartphones. OLEDs should be able to find versatile applications other than displays, because of their simple device structure, low operating voltage and design flexibility for size and shape. A simple, fast, and scalable all solution-based low temperature processing of multi-layered TFE, compatible with R2R manufacturing, is therefore needed.

In this study, organic/inorganic multilayer encapsulation structures based on one step solution-processed alternating polysiloxane and silica layer are presented as gas diffusion barriers, in which organic layers are spin-coated, followed by polymer crosslinking reaction, and finally subjected to photochemical conversion of the surface into dense silica barrier layers under exposure to vacuum ultraviolet（VUV) light. The whole process is very simple, carried out at room temperature, and the coating solution is successfully developed not to destroy the pre-formed organic emitting layer.

Transmission electron microscopic (TEM) image shows successful fabrication of multi-stacks of organic/SiO_x hybrid alternating layers (Fig. 1). The thickness of ~ 100 nm was achieved per coating. The performance of such multilayer as thin-film encapsulation (TFE) of an OLED device has also been investigated as shown in Fig. 1. The life time to go down to 90% of the initial luminance (5000 cd/m^2) was 73 hours for the OLED with TFE, about 6 times longer than that of the bare device.

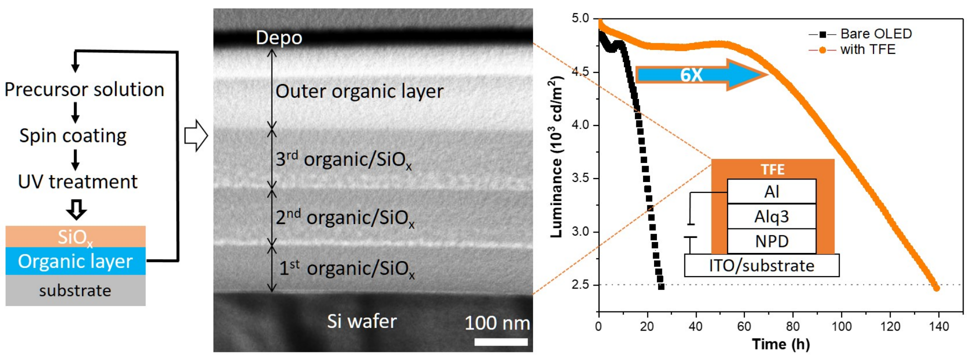

Fig. 1. Schematic illustration of solution-processed alternating organic/inorganic multilayer. TEM image shows cross-section of the prepared sample by FIB, in which bright and dark zones correspond to organic and SiO_x layer, respectively; Lifetime of OLED devices without and with 3.5 dyads of organic/SiO_x multilayer as thin-film encapsulation (TFE) were measured under constant current with an initial brightness of 5000 cd／m^2 at ambient condition.

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