Flexible Al_2O_3/Organic Multilayer Moisture Barrier Films Deposited by Spatially Resolved ALD Processes in a Single Chamber

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Thin film encapsulation (TFE) is one of essential technologies required for flexible organic light emitting diode (OLED) display devices. It is well known that organic materials are easily damaged by moisture and oxygen when plastic films are adopted for substrates. Atomic layer deposition (ALD) processes on plastic films demonstrated superior moisture barrier property to other inorganic barrier deposition processes.[1] However, extremely low throughput of ALD processes is a big huddle for commercialization and active research on 'spatial ALD' process is underway to enhance throughput.[2] To improve the barrier property further and to increase flexibility of barrier films simultaneously, various multilayer structures have been reported with various inorganic and organic layers. Since the multilayer structure consists of several thin films, the diffusion path of the barrier film can be increased and flexibility can be increased by reducing the bending stress of thin films. [3]

In this study, we deposited Al_2O_3 and organic layers in a single spatially-resolved processing chamber and demonstrated multilayer structures to achieve high barrier property and flexibility. The water vapor transmission rate (WVTR) of Al_2O_3 single thin films decreases significantly above 10nm thickness as shown in Figure 1. Organic layers were also deposited in the same chamber by plasma-enhanced chemical vapor deposition. About 20nm or thicker organic layers are required to improve the barrier film flexibility in this experiment. The total of 21 layers of Al_2O_3 and organic layers are deposited alternately and WVTR of 8.5×10^{-5} g/m^2·day was achieved. The WVTR increases by 10%, 21% and 32% in 3cm, 1.5cm and 1cm bending radius, respectively.

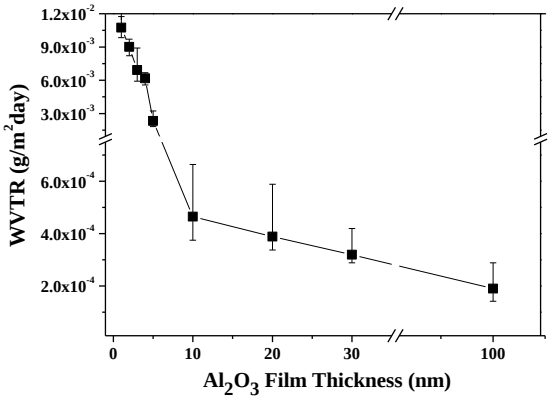

Figure. 1 The WVTR of Al_2O_3 thin films by spatially-resolved ALD process

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