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Characteristics of Al_2O_3/TiO_2 multi-layers as moisture permeation barriers deposited on PES substrates using ECR-ALD

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Flexible organic light emitting diodes (F-OLEDs) requires excellent moisture permeation barriers to minimize the degradation of the F-OLEDs device. Specifically, F-OLEDs device need a barrier layer that transmits less than $10^{-6}g/m^2$/day of water and $10^{-5}g/m^2$/day of oxygen. To increase the life time of F-OLEDs, therefore, it is indispensable to protect the organic materials from water and oxygen. Severe groups have reported on multi-layerd barriers consisting inorganic thin films deposited by plasma enhenced chemical deposition (PECVD) or sputtering. However, it is difficult to control the formation of granular-type morphology and microscopic pinholes in PECVD and sputtering. On the contrary, atomic layer deoposition (ALD) is free of pinhole, highly uniform, conformal films and show good step coverage. Thus, Al_2O_3/TiO_2 multi-layer was deposited onto the polyethersulfon (PES) substrate by electron cyclotron resonance atomic layer deposition (ECR-ALD), and the water vapor transmission rates (WVTR) were measured.

WVTR of moisture permeation barriers is dependent upon density of films and initial state of polymer surface. A significant reduction of WVTR was achieved by increasing density of films and by applying low plasma induced interlayer on the PES substrate. In order to minimize damage of polymer surface, a 10 nm thick TiO_2 was deposited on PES prior to a Al_2O_3 ECR-ALD process. High quality barriers were developed from Al_2O_3 barriers on the TiO_2 interlayer. WVTR of Al_2O_3 by intoducing TiO_2 interlayer was recorded in the range of $10^{-3}g/m^2$.day at 38°C and 100% relative humidity using a MOCON instrument. The WVTR was two orders of magnitude smaller than Al_2O_3 barriers directly grown on PES substrate without the TiO_2 interlayer. Thus, we can consider that the Al_2O_3/TiO_2 multi-layer passivation can be one of the most suitable F-OLEDs passivation films.