Flexible Plastic ITO Substrates for OLED using Vapor-Polymerized Parylene C

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Abstract

We report the fabrication of flexible plastic ITO substrates and the measurement of oxidant permeation through the substrates. The plastic ITO substrates are composed of multiple organic and inorganic thin films. The organic thin films are deposited by vapor polymerization and the inorganic films are deposited by ion beam sputtering. In order to estimate the oxidant permeation rate, the pure Ca film is formed on the substrates and the amount of CaO produced by the oxidation of Ca is measured.

1. Objectives and Background

Displays using flexible substrates offer several advantages over those using glass substrates. They are much lighter and safer because they are not breakable. Moreover, they provide the opportunity to reduce the display manufacturing cost significantly since roll-to-roll processing is possible.[1]

Since the organic light emitting devices (OLEDs) are very sensitive to moisture or oxygen, the ITO glass substrate which can prevent the oxidant permeation has been the material of choice. In order to take advantage of the flexible substrates, the oxidants such as moisture and oxygen should be blocked by way of using multiple depositions of thin transparent films on plastic substrates. Since the surface of plastic substrates is normally very rough, it should be smoothened before deposition of dense inorganic film which is primarily responsible for the prevention of oxidant permeation.

We deposit the parylene C thin films on PET substrates to reduce the roughness of the substrates by vapor polymerization[2]. The parylene C films are known to be transparent and efficient to block moisture permeation due to its dense film structure. Using the ITO substrates made with multiple films of parylene C and sputtered alumina, we estimate the oxidant permeation rate by measuring the amount of CaO produced by the oxidation of Ca with oxidants diffused through the substrates.

2. Experiment

We use the PET substrate as a base polymer substrate. In order to reduce the roughness of the substrates, the parylene C films are first vapor-polymerized on the substrates right after the plasma treatment of the PET surface for adhesion enhancement. The parylene C source is heated to 150°C for sublimation and transferred to deposition chamber through the 1 meter-long furnace heated to 700°C. The deposition is carried

out at an ambient temperature on the coolant-cooled substrate. Under vacuum, the substrates are transferred to sputter chamber and subjected to deposition of aluminum oxide thin film by ion beam sputtering. The organic and inorganic thin film deposition steps are repeated several times to pull down the oxidant permeation rate low enough.

For the measurement of oxidant permeation rate, the pure Ca film is evaporated on the flexible ITO substrates and thick Cu or Al films are grown on the substrate to seal the top. The oxidant permeation rate is estimated by measuring the amount of CaO produced by the oxidation of Ca with oxidants diffused through the substrates. The OLEDs are fabricated using the flexible ITO substrates and their lifetimes are measured.

3. References

[1]A.B. Chwang, *et al.*, Applied Physics Letter **83**, 413, 2003.

[2]M.S. Weaver, *et al.*, Applied physics Letter **81**, 2929, 2002.