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Electrical and optical behaviours of high quality TCO coatings on flexible films

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The development of flexible substrates that are based on polymer films is of critical importance to display and photovoltaic applications. Flexible substrates offer the advantages of mechanical flexibility, design freedom, optical transparency, lightweight, and cost-effectiveness. A number of inorganic functional coatings on polymers have critical properties such as water impermeability and electronic conductance, which are required for display and photovoltaic applications.

In this study hybrid transparent conductive oxide films which had the structure of ITO/ AgOx /ITO were deposited on a flexible substrate as a function of inter layers thickness and chemical status by using DC roll-to-roll magnetron reactive sputtering system. The influences of the inter layer thickness and oxygen partial pressure on the microstructure, optical properties, flexibilities and electrical properties were studied. The high quality hybrid ITO films were deposited at RT with a resistivity of $1.05 \times 10^{-4}\Omega$cm and the transparency of batter than 89%. Change of electrical and optical properties according to the inter layers and plasma conditions was also observed with XRD, TEM, and XPS. ITO films deposited at RT showed nanocrystalline phases evolved on the amorphous ITO layer[1]. Very flat surface roughness could be obtained at RT, while surface roughness of the films was increased due to the formation of grains over than 100℃. Consequently, high quality hybrid ITO films could be prepared by DC roll-to-roll sputtering with high deposition rate and at low deposition temperature; a specific resistivity of $1.05 \times 10^{-4}\Omega$cm, and Rp-vand Rrms values of surface roughness about less than 4 nm and 0.5 nm.

The mechanical failure of brittle oxide and TCO coatings on flexible polymers is a serious issue[2, 3]. The formation of defects, such as cracks and debonding in TCO films may be inevitable in situations in which bend geometries are required, because of the large difference between the elastic properties of TCO and polymers. The initiation and subsequent developments of defects mainly depend on the coating material, thickness, and interfacial adhesion. Thus, it is important to have a clear understanding of the failure behavior of coatings in the case of bend geometries, in order to prevent the destruction of devices in which they are used. Flexibility of hybrid ITO films was measured as functions of the bending radius and bending cycle in bend geometries and then shown an excellent flexibility. It will be considered that these experimental results can be applied to the TCO substrate of flexible display devices.