

## **SUPER-SMOOTH INDIUM-TIN OXIDE THIN FILMS BY NEGATIVE SPUTTER ION BEAM TECHNOLOGY**

A new ionized PVD, Negative Sputter Ion Beam technology, is described for the deposition of super-smooth indium-tin oxide (ITO) thin films with highly transparent and conductive properties at near-room temperature deposition. A limited amount of cesium vapor injected onto a conventional sputtering target surface lowers the work function of the target and produces a negatively charged sputter ion beam. The negative sputter ion beam carries the kinetic energy defined by the potential difference between the cathode and substrate.

A negatively-charged sputter ion beam was produced by retrofitting an ITO magnetron sputtering cathode with a cesium vapor injector capable of releasing controlled amounts of cesium vapor into the plasma during deposition. Experiments were performed in a down-sputtering scanning batch tool (KDF 902GT). Using this highly energetic deposition process, ITO thin films have been obtained at near-room temperature (less than 50°C) with super smooth surface (< 1nm RMS), resistivity of  $4 \times 10^{-4}$  W-cm, and transmittance higher than 90% (at wavelength 550 nm). Baseline ITO depositions were also carried out under the same sputtering conditions with no cesium injected, as a comparison. In this paper, film properties such as resistivity, transmittance over the visible spectrum, and surface roughness will be detailed as a function of cesium partial pressure during deposition. The significance of a high quality, low temperature ITO coating process applied to polymer substrates will be discussed.

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