Monday, May 11

9:30 a.m. W-1 Polyester Substrates and Vacuum Deposition: Process Optimisation for Improved Product Performance

M. Hodgson, Dupont Teijin Films UK Ltd., Wilton Centre, United Kingdom

Invited 40 min. Talk

Sputter deposition of various materials on PET webs is influenced by the low pressure environment during coating and by particular aspects of the PET surface itself. Optimising this coating/substrate interaction is of primary importance when considering the applications into which sputter coated PET substrates will be used (e.g. flexible electronics, optical films etc.), and it is essential that this interaction can be probed. In order to achieve this, characterisation of the surface before and after coating has been used to yield important information with respect to the deposition process. However, this characterisation itself is fraught with difficulty due to the anisotropic nature of biaxially drawn PET film. In this regard, careful and precise measurement of optical properties is critical to ascertain how sputter deposited layers, particularly metal oxides, interact with polyester surfaces. Ellipsometry, microscopy and optical spectroscopy have been used to ascertain the surface changes which occur during deposition and this knowledge is used to optimise the process and improve product performance.

Monday, May 11

10:10 a.m. W-2 Transparent Conducting Oxides on Polymer Substrates

S. Louch, Centre for Process Innovation, Redcar, United Kingdom; and M. Hodgson, Dupont Teijin Films, Middlesbrough, United Kingdom

This presentation will look at the sputter deposition of two important transparent conducting oxide materials; Al doped ZnO and ITO, onto plastic substrates using a roll-to-roll coater. Deposition from both metallic and ceramic targets is considered and differences in coating efficacy highlighted. A variety of techniques used to characterise these coatings will be described, and important factors such as the limitations of the substrate type and the deposition parameters will be discussed. Finally, the properties of these types of coatings specific to flexible electronic applications will be considered in view of the move towards high volume production of flexible electronic products.

Monday, May 11

10:30 a.m. W-3 Optical, Electrical, and Structural Properties of ZAO and ZGO Coatings Deposited by Magnetron Sputtering onto Plastic Substrate

R. Kleinhempel, R. Thielsch, and A. Wahl, Southwall Europe GmbH, Grossroehrsdorf, Germany

Transparent conductive oxides (TCO) with various electrical properties are essential functional parts in display applications (touch panels and LCD) or OLEDs. Tin doped indium oxide (ITO) still provides the best electrical properties at high optical transparency. Due to raising indium prices alternative TCO materials like aluminum or gallium doped zinc oxide (ZAO resp. ZGO) are the subject of intense work. The goal is to understand influences of deposition conditions in order to improve the functional properties. While deposition onto glass at elevated temperature gives best results so far, challenging demand for improved and optimized properties of doped zinc oxide thin films arise from the general trend of light weight, large area as well as from miniaturized display applications that force the use of organic substrates. The paper reports about sputtering a zinc oxide target with different dopants (Al, Ga) at different sections of the target in a production size machine onto PET. This enables a direct comparison of functional properties of ZAO and ZGO films deposited at equal process conditions as well as analysing of Al / Ga co-doped films with various concentrations. Electrical, optical and structural properties are discussed in dependence on deposition conditions and compared to ITO properties.

Monday, May 11

10:50 a.m. W-6 Low Temperature Deposition of AZO Coatings on Polymeric Web

P. Barker, G.T. West, and P.J. Kelly, Manchester Metropolitan University, Manchester, United Kingdom; and J.W. Bradley, University of Liverpool, Liverpool, United Kingdom

It would be significant to industry if TCO coatings, such as aluminium-doped zinc oxide (AZO) could be readily deposited onto flexible polymeric web, rather than onto rigid glass substrates. This would provide reductions in weight and cost of the finished products, whilst also increasing throughput and efficiency by utilising roll-to-roll web coating technology. The thermally sensitive nature of the substrates, though, currently limits the choice of deposition process. However, HiPIMS (high power impulse magnetron sputtering) may provide a solution to this problem. Despite the very high peak powers (up to MWs) achievable in this mode, the thermal energy flux to the substrate has been shown to be significantly lower, compared to other magnetron sputtering processes. Furthermore, the process also produces high levels of ionisation of the target material, which offers the potential to produce high quality TCO coatings on polymeric web without the need for post annealing processing. This paper discusses the deposition of AZO coatings onto PET web through the use of HiPIMS. The coatings have been characterised in terms of their structural, optical and electrical properties.

Monday, May 11

11:10 a.m. W-7 Deposition of High Mobility ZnO and InZnO Thin Films at Ambient Temperature Using HiTUS Based Technology for TFT Applications

J.D. Dutson, Plasma Quest Ltd., Hook, United Kingdom; A.J. Flewitt and P. Beecher, University of Cambridge, Cambridge, United Kingdom; and S.J. Wakeham and M.J. Thwaites, Plasma Quest Ltd., Hook, United Kingdom

InZnO for TFT applications. Using the novel HiTUS deposition system to remotely generate a plasma for the deposition process, it is possible to decouple the ion energy and ion density providing greater control of the deposition variables and an increased densification of the final film. This technique has been used to sputter deposit amorphous ZnO and InZnO films using a reactive deposition process with no substrate heating. The control provided by the HiTUS system enables the conductivity of the layers to be varied by 13 orders of magnitude (from 10^{-9} to 10^{+4} Ω^{-1} m^{-1}) by varying the oxygen flow rate alone. Hence, both semi-conductor and charge injection layers can be deposited by the same process. These layers have been used to produce TFT devices on a variety of substrates and dielectric insulator films. The switching properties of the complete devices have been measured and a switching ratio of $>10^6$ and field effect mobility for ZnO≈0.2 $cm^2V^{-1}s^{-1}$ and InZnO≈10 $cm^2V^{-1}s^{-1}$ have been extracted. In the full paper we describe the deposition criteria in full and present the complete set of results for the TFT devices.

Monday, May 11

11:30 a.m. WFT-2 Paucity of Materials, a Potential Constraint to the Growth of Many Markets Including Displays and Photovoltaics

C. Bishop, C.A. Bishop Consulting Ltd., Loughborough, United Kingdom (Presented by G. Tullo, General Vacuum Equipment, Raleigh, NC)

There has been plenty of publicity about the rapid increase in the price of indium. This price increase was the result of factors, such as it only being mined as a by-product of zinc and stockpile limitations. This was exacerbated by a large increase in its use for transparent conducting coatings for the display industry as well as the newer and faster increase of use within the photovoltaic industry. The net result of this was that companies suddenly found that recycling made sense and so the supply was enhanced, at least for a time, by the input of recovered indium. Observation of the metals trading markets indicate all kinds of price increases in materials that heretofore were considered abundant. In reality with the increased world population and increasing affluence, the demand for goods is increasing and the amount of materials being tied up in these goods is increasing. This requires mining more materials and, for some, this is becoming more difficult and expensive as these materials are found to be increasingly scarce. A number of these materials have already past their peak in world production and yet, in some markets, predictions of market growth appear to be oblivious to the dwindling resources that will cause inevitable shortages. These shortages are likely to affect a whole range of products from fluorescent lights, photovoltaics and light emitting diodes (LEDs). All of these are products that are aimed at reducing energy consumption of for energy production. In this paper some of the materials that are predicted to be under threat are highlighed.