Spectroscopic Ellipsometry Focus Topic
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Spectroscopic Ellipsometry Poster Session

EL-ThP3 Indium Doped Zinc Oxide as a Transparent Conductor Oxide Replacement for Thin Film Solar Cells Applications, ***Neville Sun***, *R. Sun,* Angstrom Sun Technologies Inc., *N.J. Alexander, H. Efstathiadis*, SUNY College of Nanoscale Science and Engineering

Indium doped Zinc Oxide as a transparent conductor oxide replacement for thin film solar cells applications

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Transparent conductors (TCs) are currently used in many applications, such as solar cells, displays, and electrochromic windows. TCs transparency is reduced in the infrared region due to their metallic property. Indium doped zinc oxide (InZnO) has been considered to be a substitute for the traditional indium tin oxide (ITO) to reduce indium consumption. In this work InZnO was deposited from a metallic indium target and a ceramic zinc oxide target via magnetron co-sputtering in a confocal configuration deposition tool. The films were deposited on soda-lime glass and silicon substrates and had their physical and optical properties measured. The mobility and carrier concentration was characterized by hall measurements, optical properties characterized through ultraviolet-visible-Near Infrared spectroscopy (UV-VIS-NIR), composition characterized by x-ray photoelectron spectroscopy (XPS) and band-gap characterized by spectroscopic ellipsometry.

EL-ThP4 An Innovative High-speed Spectroscopic Ellipsometry and its Novel Applications, ***Gai Chin***, ULVAC Inc., Japan

We developed an innovative high-speed spectroscopic ellipsometer. It analyzes the spectrums obtained from the polarization interference occurring between two multiple-order retarders which snapshot the wavelength distribution of the sample's spectroscopic polarization parameters. This novel spectroscopic ellipsometer can measure the thickness and optical constants of thin films at a dramatically fast speed. Its acquisition time is as short as 10 ms. It does not require the conventional complex mechanical or active components for polarization-control, such as a rotating compensator and an electro-optical modulator. It can open great opportunities for new applications of the spectroscopic ellipsometry in which the compactness, the simplicity and the rapid response are extremely important. For example, it was integrated into the deposition tool and successfully measured thin films in the vacuum chamber.

This paper describes the principle, system configuration and our innovative efforts on developing the compact high-speed spectroscopic ellipsometer. Some of the novel applications will be also introduced, such as the ALD, EUV, OLED and other measurement data for the semiconductor, flat panel display and semiconductor industries.

EL-ThP5 Spectroscopic Ellipsometry Studies of Amorphous Silicon Based Photovoltaic Devices, ***Maxwell Junda***, *L. Karki Gautam, R.W. Collins, N.J. Podraza*, University of Toledo

Strategies for improving thin film photovoltaics (PV) are largely dependent on the ability to effectively characterize the opto-electronic and structural properties of each layer and correlate these properties with electrical performance. The common approach of growing and characterizing each layer individually, outside of a complete device, is hindered by the fact that individually grown layers are often not representative of the same layer in a complete device due to substrate dependent growth processes. We have applied spectroscopic ellipsometry (SE) to extract layer thicknesses, interface composition, and optical response in the form of complex dielectric spectra ($\varepsilon = \varepsilon_1 + i\varepsilon_2$) for all hydrogenated amorphous silicon (a-Si:H) layers grown via plasma enhanced chemical vapor deposition onto rough transparent conducting oxide (TCO) coated glass. These samples are processed into single junction p-i-n PV devices and electrically characterized. Real time SE (RTSE) is used in situ, during deposition to monitor the growth evolution of each a-Si:H layer. To accurately model the initial TCO/p-layer interface, a parameterized description of the TCO structure, morphology, and ε was developed. From RTSE collected in the early stages of a-Si:H growth, changes in structural and optical properties of the TCO due to plasma exposure are tracked. Characterizing these changes to the substrate material has proved essential to accurately modeling the overlying a-Si:H layers. Leveraging previous studies that determined functional relationships for ε of a-Si:H in terms of only the band gap, physically realistic optical and structural properties for each layer are determined by allowing a minimal number of free parameters to fit models to RTSE data. This technique is effective in providing sensitivity to otherwise inaccessible material properties such as ε of the thin p-layer and subtle band gap gradients within the i-layer. Models generated from RTSE have been applied to ex situ SE collected over a spectral range of 0.04 – 5.88 eV. This combination of RTSE and infrared extended SE utilized on PV devices enables study of free carrier absorption in the TCO layers, silicon-hydrogen vibrational modes, higher energy electronic transitions in each material, and identification of spectral ranges with enhanced sensitivity to different layers and interfaces.

EL-ThP6 High Speed Spectroscopic Ellipsometry Technique for On-line Monitoring in 600x1200mm Standard Sized Solar Panel Production, *C. Major, G. Juhasz, P. Petrik,* Mta Ttk Mfa, Hungary*, ZG. Horvath,* MTA Wigner, Hungary*, **Miklos Fried***, Hungarian Academy of Science, Hungary

A macro imaging spectroscopic ellipsometer has been developed for high speed mapping of large area multilayer coated substrates. Non-contact or touchless characterization techniques based on spectroscopic ellipsometry (SE) are widely used by the photovoltaic industry for process or quality control in production. The commercialization of thin film photovoltaic (PV) technologies and the related increasing surfaces lead to many key problems such as reduced efficiency caused by multiple non-uniformities of the layers properties over the entire panel resulting from the technological steps of individual layer components. Scanning methods, based on the conventional narrow beam spectroscopic ellipsometry measurements provides high accuracy but suffer from long mapping times as the polarization state of the reflected beam must be detected. Our new instrument provides a line image of SE (wl=350-1000 nm) data with a lateral resolution of ~20 mm, thus SE information of 1800 points can be collected less than 600 sec over a 600 x 1200 mm PV material and it could be several 10 times faster than a conventional scanning method. In this paper the calibration were carried out on SiO2/c-Si structures and test measurements on a-Si films grown on soda lime glass (transparent samples) are presented.

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