Optical Characterization of Plasma-Deposited SiO2-like Layers on Anisotropic Polymeric Substrates
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Spectroscopic Ellipsometry III

Moderator: M. Schubert, University of Nebraska - Lincoln

8:00am AS+E+M+MS+TF-TuM1 Optical Characterization of Plasma-Deposited SiO2-like Layers on Anisotropic Polymeric Substrates, G. Aresta, Eindhoven Univ. of Tech., The Netherlands, A.P. Premkumar, Materials Innovation Inst. (M2i), The Netherlands, S.A. Starostin, Eindhoven Univ. of Tech., The Netherlands. H. de Vries, FUJIFILM Mfg Europe B.V., The Netherlands, M.C.M. van de Sanden, M. Creatore, Eindhoven Univ. of Tech., The Netherlands

Amongst the most common thin film characterization tools, spectroscopic ellipsometry (SE) is increasingly used to determine the layer optical properties. Such characterization is still a challenge when optical anisotropy is present either in the film or in the substrate. The study of thin films deposited on polymeric substrates is an example because polymers often show optical anisotropy. In this contribution the optical characterization of poly(ethylene 2,6-naphtalate) (PEN) in its transparent region is carried out showing optical anisotropy. In this context the optical characterization of thin films deposited on PEN by direct co-evaporation is presented in order to evaluate the optical properties of this material. The full characterization of the in-plane and out-of-plane anisotropy and orientation of the material index ellipsoid, with respect to the laboratory frame, is performed using the SE measurements. The full optical characterization of PEN substrates has been carried out first by identifying its in plane anisotropy (i.e. $\Delta n_x = n_x - n_y$) and in-plane orientation of the material index ellipsoid with respect to the $x$ axis, by means of TGE measurements at $0^\circ$ angle of incidence. A second step consisting of TGE measurements at different angles of incidence has allowed the determination of the out-of-plane anisotropy (i.e. $\Delta n_z = n_z - n_x$) and the material index ellipsoid out-of-plane orientation with respect to the $z$ axis. Finally, the full optical characterization of PEN substrates has been carried out using TGE measurements at different angles of incidence allowing the determination of the optical anisotropy and orientation of the material index ellipsoid with respect to the laboratory frame. The optical characterization of polymer substrates is of extreme importance for many applications, such as displays, photovoltaics, and photonic devices. In this contribution, the results of SE measurements on PEN substrates are presented, showing the importance of optical anisotropy in polymeric materials. The measurements were performed using a variable angle spectroscopic ellipsometer (VASE) and allowed the determination of the optical parameters of the PEN substrates. The optical parameters were fitted using an iterative optical modeling software, permitting detailed analyses of processes that went wrong - or right. The analysis of data allows to diagnostics, to an increase in film density with the duty cycle.

References:


8:20am AS+E+M+MS+TF-TuM2 Spectroscopic Ellipsometry in the Mid IR and U V-VIS for Investigating Low Temperature Plasma Activated Wafer Bonding, T. Plach, K. Hingerl, University Linz, Austria, V. Dragoi, M. Wimplinger, EV Group, Austria

Low temperature plasma activated direct wafer bonding (LTPADBWB) for Si-SiO2 interfaces is a process that lowers the required annealing temperatures, (from usually 900°C down to 250°C) necessary for reaching high bond strength. The mechanism behind this improvement is still under discussion: The low temperature steps for the hydrophilic process are interpreted as follows: Up to 100°C the substrate surfaces are held together via van der Waals interaction which is mediated by a few monolayers of water. In the range of 100-200°C the water diffuses away from the interface both along the interface and through the oxide into the crystalline bulk, where it reacts with the silicon and forms oxide. The remaining half of the bond strength is usually attributed to a closing of gaps at the interface[1], which starts with conventional techniques at the softening temperature of the thermal oxide at around 850-900°C. In comparison the same surface energies for the LTPADBWB process are already reached at 250°C. To clarify the mechanism for this process, different bonding experiments were performed to evaluate the lifetime of the surface activation and the achievable bond strength when using substrates with various orientations. By covering half of the wafer during plasma activation, comparisons between the activated and non-activated region could be made by mid IR and UV-VIS spectroscopic ellipsometry covering the energy range from phonon energies to the UV (30meV-6.5eV). It turns out that the spectral shape of the phonon peaks as well as the spectral shape of the critical points in the UV ($E_1, E_2$) significantly change and even the peak position changes.

Correlation measurements, by Auger analysis and by X-ray photoelectron spectroscopy, interfaces of bonded wafer pairs have been performed in addition, as well as by transmission electron microscopy (TEM). TEM clearly shows that there is no discernible interface between the native oxide on one side and the thermal oxide on the other side. From the spectroscopic ellipsometry data it was found that the top surface stoichiometry is chemically changed, which favors bonding. Finally a model for the mechanism that explains the experimental results will be presented.[1] Q.-Y. Tong, U. Gösele, Semiconductor Wafer Bonding: Science and Technology, Wiley

Tuesday Morning, November 10, 2009