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Correlation of applied substrate-bias and barrier properties of ultra-thin SiOx films by means of combined electrochemical and FTIR-spectroscopic investigations

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Thin SiO_x plasma polymer films have been intensively researched due to the diversity of their application possibilities. They can be utilized as thin corrosion protection films on engineering metals as well as be applied on flexible packaging materials to improve their barrier properties. The barrier properties of SiOx-like plasma films strongly depend on the film chemistry and morphology. Deposition parameters, such as applied substrate bias is reported to enhance the barrier properties, even at low oxygen partial pressure during deposition. This paper is about the relationship between the plasma parameters (plasma gas composition and substrate bias) and barrier properties assessed by means of electrochemical investigations. Ultra-thin SiO_x films were deposited on Pt and Au electrodes from Hexamethyldisiloxane (HMDSO) precursor and oxygen containing gas phases. Deposition was performed via a low pressure microwave plasma to study the effect of process parameters on film properties. The presence of nanodefects and surface coverage was investigated by means of Electrochemical Impedance Spectroscopy (EIS) and Cyclic Voltammetry (CV). At constant O_2:HMDSO ratio, increasing substrate-bias led to less nanoscopic defects. This was attributed solely to the changes in the film network density, since the overall chemical composition was proven to be not affected by the applied substrate-bias. In order to confirm the existence of free silanol dangling bonds, FTIR characterization was performed via proton exchange measurements. The amount of interglobular and surface hydroxyl groups were monitored by means of discrete polarisation modulation Fourier transform infrared reflection-absorption spectroscopy (FT-IRRAS) in atmospheres with controlled humidity. Presented results will demonstrate the correlation between the deposition parameters of thin SiO_x films, the density of dangling bonds and their influence on barrier properties. *The authors gratefully acknowledge the support provided by the Deutsche Forschungsgemeinschaft (DFG) within the framework of the SFB-TR 87.*

Keywords
Electrochemical impedance, SiOx plasma polymer, FT-IRRAS