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Silicon oxide permeation barrier coating of PET in microwave plasmas with arbitrary substrate bias

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Plastics such as PET offer limited barrier properties against gas permeation. For applications of PET in many branches (from food packaging to micro electronics) permeation barriers are essential to get shelf lives comparable to glass or metal packages. A permeation barrier coating of the inner surface of PET bottles and PET foils is developed by means of a microwave driven low pressure plasma reactor based on a modified Plasmaline antenna. While microwave power allows for a control of the ion flux during the plasma pulse a substrate bias with arbitrary waveforms is applied to control the energy of ions impinge on the substrate. Therefor, the substrate electrode voltage is feedback controlled using fast Fourier transformation to design the ion energy distribution. The influence of a substrate bias leading to variable ion energy distributions is investigated with respect to the characteristics of plasma and coating.
To get defined plasma conditions the plasma process is characterized using diagnostics such as optical emission spectroscopy, Langmuir probe and energy mass spectrometry. The composition of the coatings is analyzed using x-ray photoelectron spectroscopy (XPS). Another technique applying atomic oxygen etching of the coated substrate visualizes coating defects responsible for a residual permeation flux. Crack formation mechanisms are studied in-situ by means of atomic force microscopy (AFM) using an AFM-stage to apply a desired strain. In addition, the evaluation of water up-take in barrier films was performed. The results show how process parameters such as gas composition and substrate bias have an impact on properties of permeation barrier coatings.
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