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Mechanical durability of single and multi layer permeation barriers on flexible polymer substratesJohn Fahlteich¹, Hendrik Drese², Matthias Fahland¹, Nicolas Schiller¹¹Fraunhofer FEP, Dresden, Germany ²CyBIO AG, Jena, Germany

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Permeation barrier layers are not only used for food packaging but also needed to encapsulate flexible electronic devices. Commonly two approaches are followed to achieve very low water and oxygen permeation through a coated polymer film: low defect single layers and multi layer stacks consisting of several barrier layers with polymer interlayers. In this paper both single and multi layer barriers on a commercial-grade polyethylene terephthalate substrate are characterized and compared regarding their permeation barrier properties and defect density as well as cracking behavior in a linear strain test. Therefore reactively sputtered zinc tin oxide (ZTO) barrier layers have been combined with SiO_xC_yH_z interlayers deposited using a Dual-Magnetron-PECVD process. The defect types, sizes and densities in single layers and different multi layer stacks are characterized using optical microscopy and scanning electron microscopy (SEM). Mechanical durability has been observed using a linear strain test in combination with both an optical microscope and a SEM. Both the crack onset strain and the crack density and size evaluation with increasing strain load have been determined. The influence of defects in the layers on the cracking behavior has been investigated. Also the water vapor transmission rate (WVTR) under linear strain and after relaxation has been measured for both the single and multi layers.

Multi layer stacks, consisting of at least two barrier layers with an elastic interlayer, have several advantages compared to thick single layers. The crack onset strain of multi layers is higher compared to thicker single layers with the same water vapor transmission rate. While the WVTR of single layers is as high as the WVTR of the uncoated substrate after strain and relaxation, multi layers surprisingly show a considerably low WVTR after the strain test and relaxation of the sample. Thus, multi layers are more tolerant against temporary application of strain e.g. during roll-to-roll processing.

Keywords

permeation barrier
linear strain test
zinc tin oxide
polymer substrate
defects