DEPOSITION OF SIO_X DIFFUSION BARRIER FILMS ON FLEXIBLE PACKAGING MATERIALS BY PLASMA ENHANCED CHEMICAL VAPOR DEPOSITION

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Nano-sized silicon oxide films deposited by plasma enhanced chemical vapor deposition (PECVD) are receiving considerable attention in the packaging industry due to their excellent gas barrier performance. These films offer several advantages: Besides their barrier performance, they are transparent, colorless, and microwaveable and do not affect recyclability. PECVD allows the deposition of ceramic films at low temperatures, which makes it suitable for the treatment of thermosensitive materials such as polymers.

The experimental set-up used in this study is made up of a cylindrical batch reactor, equipped with two plasma sources, a gas feeding system, and a pumping unit. The microwave-driven source (2.45 GHz) is located upstream of the reactor, while the radiofrequency-biased substrate holder (13.56 MHz) is placed in its afterglow. It can, thus, be operated in three modes: Microwave(MW)-, radiofrequency(RF)- or dual-mode. Oxygen-diluted hexamethyldisiloxane was used to deposit the thin films onto polyethyleneterephthalate.
The influence of the deposition process parameters on the oxygen permeability of the films has been studied intensively. The film composition and morphology has been analyzed by ellipsometry, atomic force microscopy (AFM) and X-ray photoelectron spectroscopy (XPS).

It has been shown that the film densifying effect of ion bombardment, caused by a negative substrate potential relative to the plasma, is a key issue for the deposition of good quality barrier films. This so-called substrate bias is a characteristic of RF plasmas but is neglectable for MW-plasmas. Silicon oxide films, deposited in a pure MW plasma did therefor not show satisfying barrier performance [1]. However, in RF- and dual-mode oxygen barrier improvement factors up to 1000 could be achieved for 12 μm PET films.

The influence of film defects on the gas permeation through monofilms and laminates has been investigated by means of FEM simulations. The results of these calculations, presented in dimensionless form, provide a guideline for the design of composite packaging materials, including thin barrier films, with respect to the order and thickness of the single layers [2].

[1] A. Gruniger and P. Rudolf von Rohr, Surf. Coat. Technol., **174** (2003) 1043.
[2] A. Gruniger and P. Rudolf von Rohr, Thin Solid Films, (to be published 2004).