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Plasma Treatment and Silicon Oxide Permeation Barrier Coating of PET Bottles and Foils

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Over the last decade there was a growing demand for PET bottles on the world market. An increasing part of carbonated or non-carbonated and non-acidic beverages like water, juices and ice tea is bottled in PET. These bottles have advantages in weight and fragility compared to glass bottles but they offer only limited barrier properties against gas permeation. To solve this problem one solution is coating the bottles with thing film that works as a gas permeation barrier.

1 Introduction

On the world market there was a growing demand for bottles made of PET. An increasing part of carbonated or non-carbonated and non-acidic beverages like water, juices and ice tea is bottled in PET. Despite of a reduced weight and fragility compared to glass bottles there are certain disadvantages. For instance PET bottles have a worse barrier against gas permeation through the walls. Furthermore products of decomposition from the PET migrate into the beverage and can influence taste and quality of the product. A solution to overcome these disadvantages is do deposit a thin glass-like silicon oxide layer inside of the bottles. This layer offers a great barrier against gas permeation. Hence an extended and improved shelf-life of oxygen-sensitive beverages can be achieved [1].

For the silicon oxide coating on the inner side of a PET bottles, a special low-pressure microwave plasma reactor with a volume of about six litres was developed. The plasma chamber was built to carry either a 0.5 l, 1 l or 1.5 l bottle. A coaxial waveguide combined with a gas-inlet, called PlasmalineÂ®, is used for injecting the microwave power and a gas mixture into the bottle. As a barrier a SiO_x coating is deposited using Hexamethyldisiloxane (HMDSO) as a monomer. The plasma chamber provides several flanges to allow for different diagnostic applications (e.g. Energy-Mass-Spectrometry, Langmuir probe measurements and Optical-Emission-Spectroscopy).

Future topics of our working group are aimed at understanding the mechanisms of plasma deposition of SiO_x barrier coatings with respect to ions, neutrals and radicals to gain a understanding and to investigate the capabilities of the barrier coating, considering e.g. roughness, homogeneity, adhesion and barrier properties.

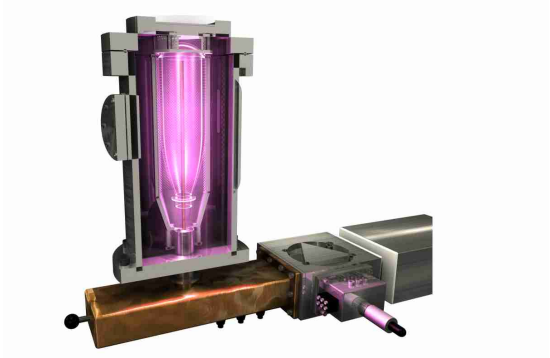

Figure 1: Low-pressure microwave plasma reactor.

References

[1] S. Steves, PhD thesis, Ruhr-Universität Bochum (2013)