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Tailored degradability of plasma polymers with semi-classical structure

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Polymers prepared by classical “wet“ chemistry methods typically possess well-defined molecular structure. However, significant degree of crosslinking without residues of the crosslinking agent is not easily achievable for many types of polymers. In contrast, plasma polymers usually exhibit very high degree of crosslinking, yet with poorly defined molecular structure. Plasma assisted vapour thermal deposition is a combination of these two approaches. Powder of bulk polymer (“precursor“) is heated under vacuum to the temperature at which the cleavage of macromolecular chains starts to occur. Oligomeric fragments are released into the gas phase through a glow discharge, forming a thin film. The retention of the macromolecular structure and the crosslink density are tuned by the conditions in the plasma.

In this work, thin films based on poly-lactic acid, polyethylene oxide and polyurethane were prepared at temperatures of 150-350°C under low pressure (1-5 Pa) with/without the RF plasma (0-20W) involved. The molar mass distribution and the chemical composition of the resultant films were characterized in comparison with the “precursor” polymers. Swelling and hydrolysis of the films were monitored as a measure of their degradability using liquid chromatography and in situ spectroscopic ellipsometry. Permeability of model molecules (e.g. nisin) through the films was studied. In general, the films replicated well the structure and the chemical composition of the original counterparts. The degradation and permeation properties were found to be tunable to a significant degree by the deposition conditions.

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