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Formation of plasma-generated nanostructures on polymer surfaces for various polymer types

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The generation of nanostructures has become an attractive alternative method for the deposition of anti-reflection coatings. Besides applications based only on anti-reflection properties, a nanostructure, with its exceptionally enlarged surface area, can also enhance the adhesion of wet chemical lacquers on a polymer surface. Many other methods for promoting adhesion have considerable disadvantages. Several etching agents and primers lead to a cracked and hazy appearance of the polymer substrate. Mechanical roughening and common plasma pretreatments can affect either the morphology or the chemistry of the surface and do not enhance the adhesion to a satisfactory level in many cases. For the last seven years, the generation of nanostructures on polymer surfaces by plasma etching has been one of the major research topics of our group. Optimization of the anti-reflection effect on PMMA and transfer of the structuring process to PET web material have been performed with success. However, to broaden the range of processable materials, basic research was necessary because the mechanism of the formation of self-organized nanostructures remained unclear.
In this study, experiments were carried out to generate nanostructures that could be suitable for adhesion enhancement. Diverse polymer materials such as PMMA, PET, TAC, polyamide, polycarbonate, polyimide and COP were compared for their ability to form surface textures by self-organization under plasma exposure. It was found that extreme differences occurred in the resulting surface topography after a long treatment with a Leybold APS plasma ion source. Whereas structural features with a depth of more than 500 nm appeared on PMMA, PET and TAC, other polymer types were textured to a depth of only 80 nm. For polycarbonate, no structure formation at all could be observed, despite absolutely identical etching conditions. The ablation rates of the individual polymers showed no significant correlation to the texture growth. This led to the conclusion that the polymer chemistry plays a major role in this nanostructure formation.[4]

Keywords
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