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Thin film growth on nanostructured polymer webs for anti-reflection purposes

Peter Munzert[1], Ulrike Schulz[1], Norbert Kaiser[1], Waldemar Schönberger[2], Matthias Fahland[2]

[1]Fraunhofer Institute for Applied Optics, Jena, Germany [2]Fraunhofer Institute for Electron Beam and Plasma Technology, Dresden, Germany

peter.munzert@iof.fraunhofer.de

Transparent polymer webs offer a considerable application potential in high quality optical devices like e.g. projection displays. In many cases the reflection of light at the webs surface is undesired and disturbs the optical function. Polymer films with anti-reflection coatings are commercially available but expensive. Because of the high production costs for elaborate coating procedures there is no producer of such coated webs in Europe. Nanostructures offer an alternative way to add antireflection properties to a surface but most of the structuring techniques are quite complex and hardly scalable to the typical dimensions of the web processing lines. At the Fraunhofer-IOF in Jena a method to generate nanostructures on a PMMA surface by using a simple plasma etching procedure exists. Now the attempt is to transfer this technique to polymer webs in a roll-to-roll process with the intention to create a highly effective and low cost anti-reflection surface. At the initial state of this project the structuring behaviour of typical web materials like PET or TAC was investigated. Two different kinds of the nanostructure's geometry could be generated on each polymer material. Pure plasma etching led to a self-organization of "conus-like" bumps while with the deposition of a 1nm thin titania layer before the etching process a rather "sponge-like" structure occurred. Important for prospective applications of the webs is the protection of the nanostructured polymer surface by a thin ceramic layer. The challenge of this task is to enhance the mechanical stability without deteriorating the anti-reflection effect at the same time. First experiments with the deposition of SiO_2-layers in a thickness range from 15nm to 45nm on nanostructured PET and TAC samples showed noticeable differences for the received spectral reflectance. While for "bump-like" structures the average residual reflection could be minimized with increasing the overcoat thickness, the reflectance spectra of the "sponge-like" samples were simply shifted to longer wavelengths. An explanation for this could be given by the different growth of SiO_2 coatings what was identified in SEM micrographs. While on a "bump-like" nanostructure the film enwraps the bumps and boosts the material/air fill factor in a suitable range for anti-reflection, a coating on a "sponge-like" structure closes the voids and growths predominantly on the structure top.

Keywords
nanostructures
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