Coating of new polymers for optical applications

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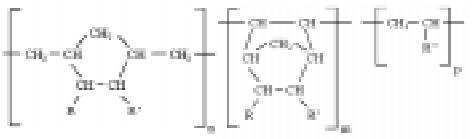

Fig. 1:
Molecular structure of the new polymers
left: Cycloolefin-Polymer (COP) ZEONEX®
right: Cycloolefin-Copolymer (COC) TOPAS®

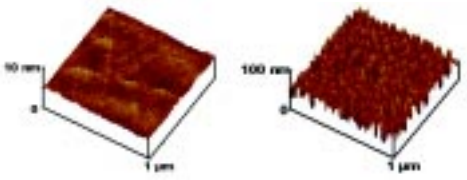

Fig. 2:
AFM images of a Zeonex substrate
(left: untreated, right: after Ar-plasma treatment 1800s, 80V BIAS)

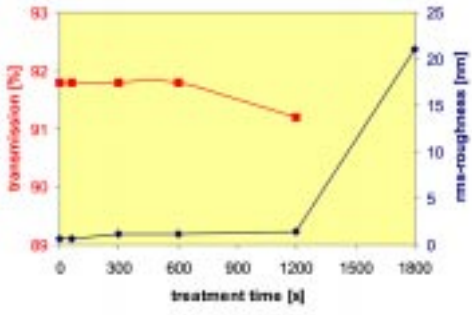

Fig. 3:
Rms-roughness and transmission (at 400nm) of a Zeonex substrate (1mm thick) depending on Ar-plasma treatment time with 80V BIAS

New polymers will play a major role as materials for optics and optoelectronics in the next decades. A new class of amorphous thermoplastics, the cycloolefinic polymers (known as ZEONEX® and TOPAS®), was introduced to the world market about five years ago /1/. These materials promise considerable advantages concerning optical properties, heat distortion temperature and water uptake compared to PMMA and PC, which are still common materials for optical applications until today.
Surface functionalisation by thin film coatings is one of the main requirements for plastic optical parts. High scratch resistance, anti-reflection properties, electrical conductivity or wettability of polymer surfaces can be obtained by coating with inorganic layer systems.
For PVD (physical vapor deposition) -coating problems, like adhesion of the inorganic layer on the organic substrate, a solution must be found for every single polymer. Broad basic coating knowledge exists only for PMMA and PC as a result of many years of research.
Our investigations are part of the project "Polymere 2000", which is financed by the Arbeitsgemeinschaft industrieller Forschungsvereinigungen (AiF) under AiF-FV-Nr.12180BR. More than 10 different companies from the optics and coating industry take part in the project committee.

Aim of this project is to investigate the coatability of cyclopolyolefin substrates and their behavior under evaporating and pretreatment conditions, to create a basic knowledge base for the development of industrial coating procedures.
The behavior of ZEONEX® and TOPAS® sample surfaces under pretreatment and coating conditions, simulated by Ar ion bombardment and UV radiation from a plasma, has been investigated. It was possible to increase the samples free surface energy with Ar-plasma pretreatment, even with short treatment times (< 5s). A high surface energy value is a condition for good coating adhesion. For extremly long plasma treatment times a strong increase of surface roughness as well as a decrease of transmission in the visible wavelength range were determined.

The results indicate that normal coating conditions with pretreatment times < 300s and moderate BIAS-voltage will not influence a polycycloolefin surface in a negative way. Above that, very short plasma pretreatment is sufficient to increase free surface energy values, so the "possible parameter window" of PVD-coating processes should be much wider for the polycycloolefins than for PMMA or PC.

References

/1/ T. Kohara, Macromol. Symp. 101 (1996) 571-579