Abrasion resistant antireflection coatings for plastic optics

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Transparent plastics like PMMA, Polycarbonate, COC and Zeonex are widely used today for optical and optoelectronic components.
Coating of these soft components is mainly intended to improve their mechanical durability. Additionally, antireflection coating is necessary for many optical applications.
Plasma-Ion Assisted Deposition (Plasma-IAD) using plasma source APS is a well applied technique to deposit optical interference coatings without additional substrate heating. Nevertheless, temperature on a polymer substrate can reach a critical value of about 90°C and higher if thick layers have to be deposited. The increase of temperature is mainly determined by the high energy of electron beam gun during evaporation of high refractive material Ta_2O_5.
A new coating design AR_hard (Fig. 1) has been developed to produce abrasion-resistant antireflective coatings on plastics. In contrast to other antireflective coatings, high refractive index layers are almost evenly distributed over the stack. The total thickness of coatings of this design type can be adjusted from about 800 nm to over 2200 nm. The temperature on plastic substrates during the PVD process has been reduced compared to common coating stacks by using thinner layers with high refractive index (Fig 2).

The coating has been deposited on PMMA, PC, Zeonex and COC. The average reflectance of plastic surfaces was reduced from about 4–5% to values lower than 0.5% in the visible spectral range. The abrasion resistance of the coatings deposited on plastics corresponds to that of a single SiO_2 layer of the same thickness (Fig. 3).

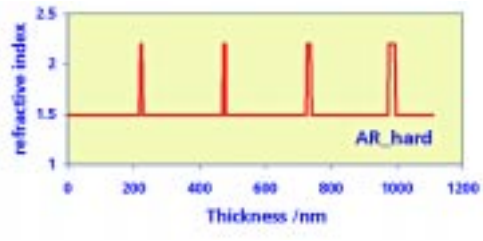

Fig. 1:
Coating design AR_hard – schematic presentation of the alternating high index (n = 2.0) and low index (n = 1.46) layers in dependence on geometrical thickness of coating.

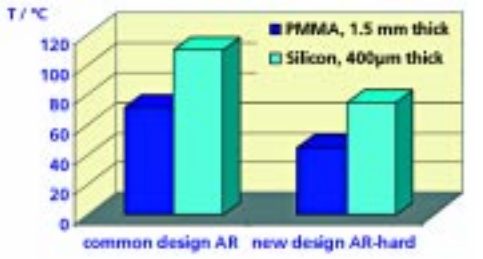

Fig. 2:
Maximum temperature on backside of PMMA and silicon-substrates during coating with common antireflective system and using the novel design AR_hard.

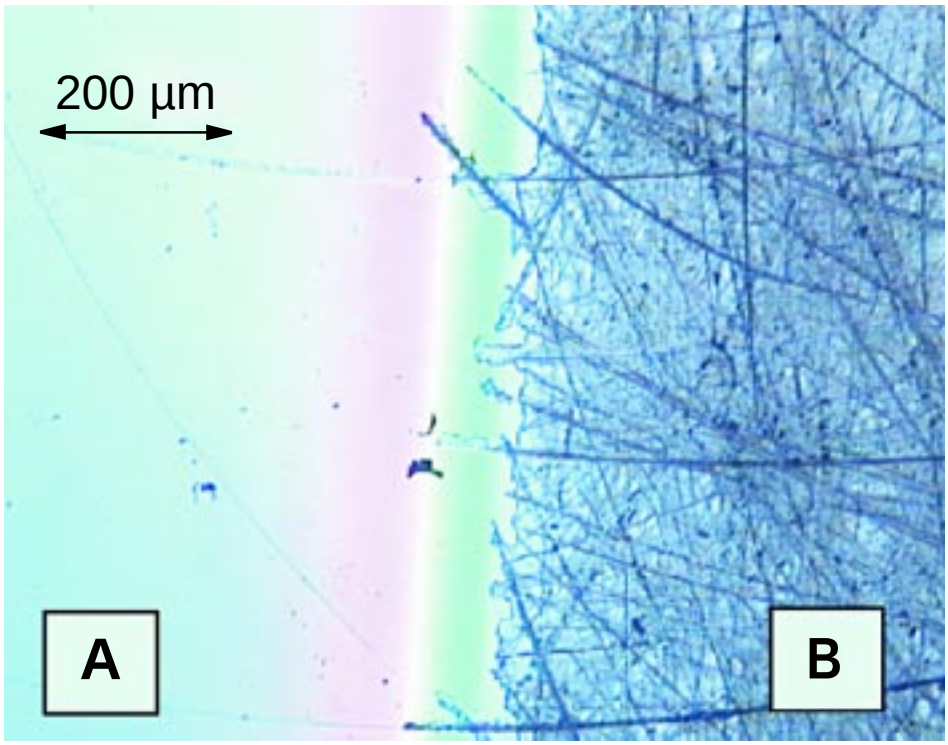

Fig. 3:
Light Microscope image of PMMA-samples after rubbing with Steel Wool (F » 0.1 N)
A – coating AR_hard, B – no coating