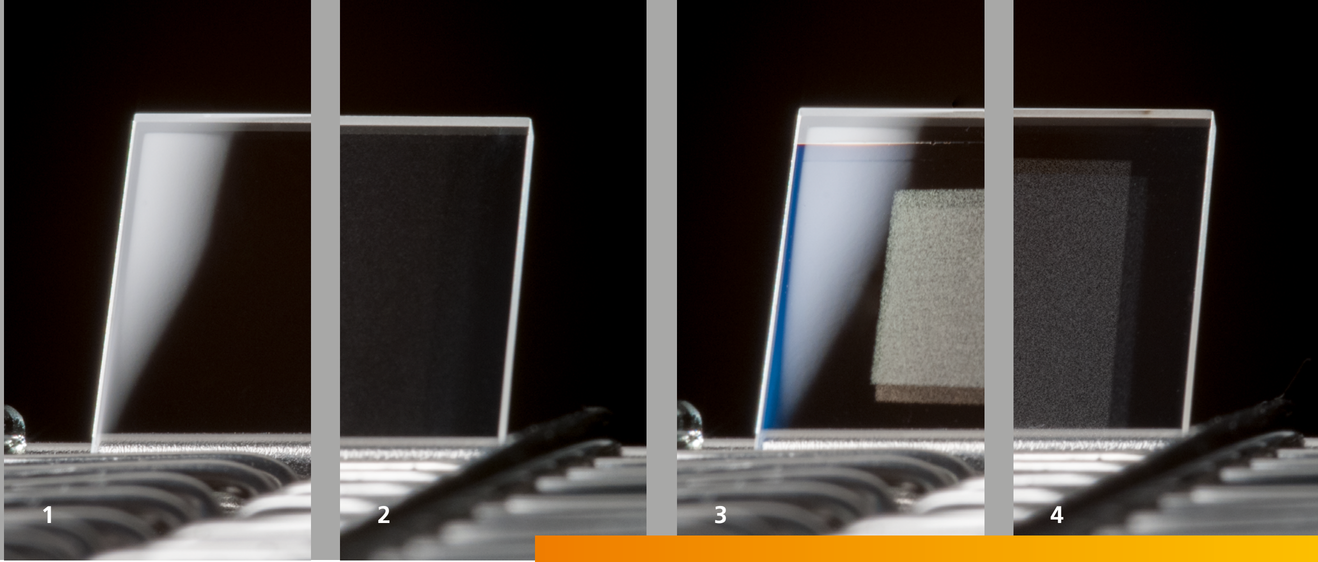

Extract from the annual report 2013
To the website: www.ist.fraunhofer.de/en.html

SCRATCH-RESISTANT ANTIREFLECTIVE COATINGS

Items of daily use such as watches or cell phone displays are constantly exposed to abrasive friction and impacts. In many cases particularly hard sapphire glasses based on artificially grown aluminum oxide crystals are used to protect them. However, when compared with normal mineral glasses, they have one distinct disadvantage: they are highly reflective and this makes it more difficult to see objects behind the glass. For this reason the Fraunhofer IST has, as part of the EU project "NoScratch", created antireflective coatings which show minimal abrasive wear even under the most extreme conditions.

Structure of antireflective coatings

Antireflective coatings usually consist of a layer of high-refracting titanium oxide or silicon nitride and one of low-refracting silicon dioxide (silica). Due to the interference conditions the top layer here must be the silica. But this particular material cannot offer sufficient resistance to abrasive influences. A layered system with a top layer of aluminum oxide would have this resistance but there would be too much residual reflectance. For this reason, material mixtures of silicon oxide and aluminum oxide were among other things investigated as part of the "NoScratch" project in order to make the positive properties of each of the two materials usefully accessible.

Resistance provided by optimized processes and materials

On the basis of plasma simulations the coating process was optimized up to a high input of energy. A bipolar sputtering process at medium frequency was used here. Compaction of the deposited coating was assisted by direct heating and a substrate bias. With this method even industrial anti-reflective systems based on silicon nitride and silicon oxide can be even further improved. The addition of aluminum oxide to the silicon oxide results in a change in the layer hardness. A suitable choice of mixing ratio ensures that when rubbed with sharp-edged corundum particles in the tightened Bayer test (oscillating abrasion test) the topmost layer loses hardly any material. Antireflective properties are thus left unaffected. When the layer is subjected to the impact of the same particles in the sand trickling test, noticeably fewer bits of coating break away, resulting in a reduction in light scatter.

Characterization

In addition to coating technology, the Fraunhofer IST also has at its disposal various standardized test methods for determining wear resistance. These have been specially adapted to the requirements of dielectric coatings such as antireflective systems. Among other things the increase in light scatter following the sand trickling test can be determined, as also the thickness of the abraded coating after the Bayer test. Supplementing the familiar photometric measurements (reflectance, transmittance, light scatter) and ellipsometric measurements (material parameters, coating thicknesses), these tests can now also be carried out on substrates supplied by the customer.

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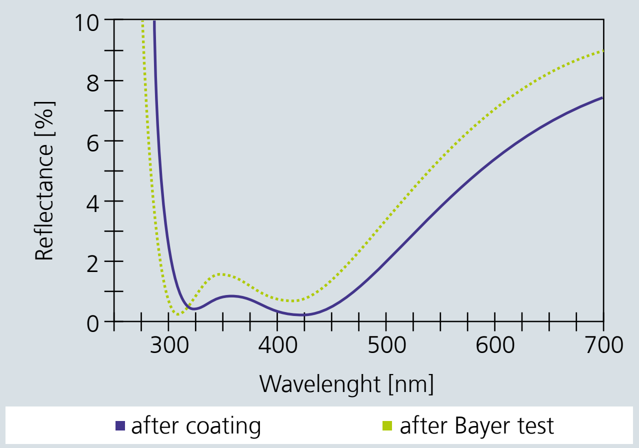
Minimal increase of the residual reflectance of a antireflective coating following abrasion in the Bayer test resulting from the use of a silicon-aluminum oxide mixture.



1 *Sapphire glass before testing.*

2 *Sapphire glass after the sand trickling test.*

3 *Standard antireflective coating after the sand trickling test.*

4 *Optimized antireflective coating after the sand trickling test.*

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