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Letter to the Editor

Protecting properties and behaviour of antireflection coatings

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Introduction

Many white and coloured optical glasses, e.g. those based on a phosphate glass or containing some colorants, like nonmetallic elements or their compounds, tarnish when exposed to high humidity and temperature of the atmosphere. They can be protected by being cemented between two stable glasses or by deposition of protective layers.

Some manufactures provide in their catalogs the detailed data about chemical resistance of glasses. Durable layers can be prepared by using well known antireflection coatings [1] which improve the threshold resistivity. The protecting properties and behaviour of these coatings depend on the environment (like humidity of atmoshpere) as well as on the film/substrate chemistry.

The investigations on this subject are continuously performed [2, 3] but very few results are publishing in spite of their importance.

Experiment and method

Several plates of white glass SK 16 and coloured glass BG 22 were protected by antireflection coatings. The diameter of the samples was 30 mm and the thickness — about 1 mm. After the fresh optical conventional polishing, the plates were washed in ethyl alcohol, then dried and rubbed with a cotton towel.

Three kinds of antireflection coatings: a quarter-wave-layer of MgF_2, half-quarter-wave layer of TiO_2/SiO_2 and half-quarter-wave-layer of Al_2O_3/MgF_2 were respectively deposited onto the above mentioned plates of SK 16 and GB 22 glasses.

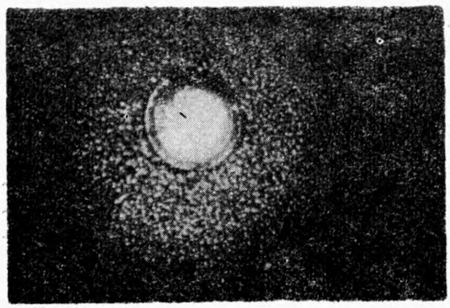
Ten clean substrates, divided in two groups according to the kinds of glasses used were coated simultaneously in a chamber evacuated to about 2–3 mPa. The coatings were deposited in standard high vacuum evaporation plant equipped with oil diffusion pump and rotary backing pump. The materials like MgF_2 and TiO (starting material) were normally and reactively evaporated from resistance-heated Ta and W boats. The electron beam gun was used for evaporation of Al_2O_3 and SiO_2. Prior to deposition, the substrates were heated to about 550 K and bombarded by ions being produced in glow discharges immediately before the evaporation was started. During deposition the layers were controlled by optical monitor using the green light (525 nm). The deposition rates were about 2–3 nm/s for MgF_2 and 0.2–0.5 nm/s for other materials.

More than 30 samples of the two kinds of glasses protected by three kinds of coatings were simultaneously tested at 85% humidity and 323 K $\pm$ 1 K temperature inside the closed glass jar. The method used for the humidity testing of coating/ /glasses is similar to that used for optical glasses in Polish optical industry. The detail information can be found in [4].

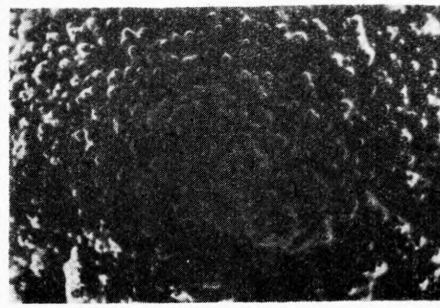
The information about protecting properties of the samples tested has been obtained by determining the number and area of the spots of nongreasing deposit, e.g. drops or crystals, which appeared in the same time* on the surfaces tested. For this purpose a dark field microscope of 100 × magnification has been used.

Results and conclusions

To verify and illustrate the results of the humidity testing of coatings/glasses, the pictures of surfaces were taken and shows in the figure.



Aa



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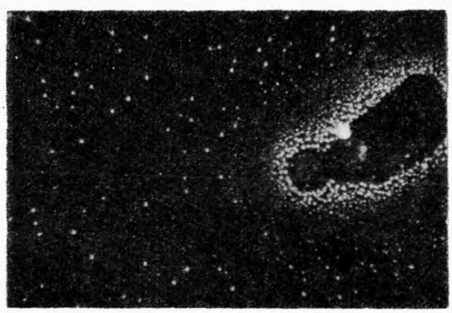

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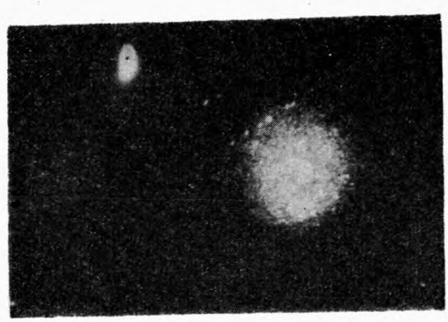

Bb

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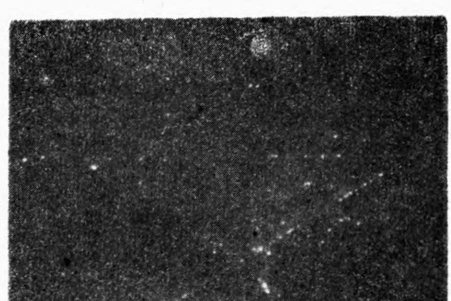
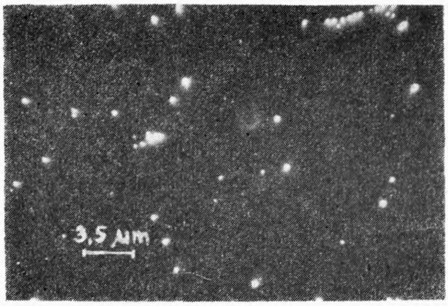
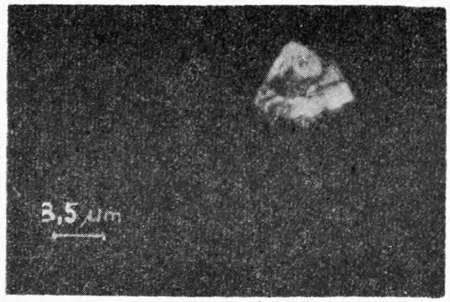


Bc

* The used time depended upon the sort of tested coatings/glasses, e.g. 100, 400 or 1000 hours



Ad



Bd

The typical areas of the spots (after a 400 hour humidity testing) for samples of glass SK 16 (A) and glass BG 22 (B): a – without coating, and b, c, d protected by antireflection coatings consisting of quarter-wavelength-layer of Mg_2F (b), or half-quarter-wavelength-layers of TiO_2/SiO_2 (c), or half-quarter-wavelength-layers of Al_2O_3/MgF_2 (d). The wavelength is 535 nm

From these pictures it follows that the TiO_2/SiO_2 layer is a relatively better protecting coating for SK 16 glass while the Al_2O_3/MgF_2 layer works better for BG 22 glass. These results evidence that protecting properties of TiO_2/SiO_2 or Al_2O_3/MgF_2 layers depend on the kind of glass.

From these investigations it may be concluded that the protecting properties and behaviour of the selected antireflection coating for optical glass depend not only on duration of humidity treatment but also on the film/substrate chemistry.

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References

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