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Abstract

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STABILIZATION OF SILVER CHLORIDE CRYSTALS WITH RESPECT TO THE AC- TION OF SOLAR RADIATION

(Presented by Academician A. V. Shubnikov on 10 V 1965)

Crystalline silver chloride is one of the best optical materials transparent over a wide range of wavelengths of the optical spectrum. AgCl transmits up to 80% of radiation (0.4–25 μ) and, in comparison with other alkali-halide crystals used in infrared technology, is more stable: it does not dissolve in water or acids and does not adsorb water.

Owing to the high plasticity of AgCl, it is possible to manufacture articles from it—lenses, cuvettes, prisms, windows, light guides, etc.—by pressing, drawing, stamping, rolling, and so forth^(2,3). The combination of transparency and mechanical properties similar to those of metals makes it possible to use silver chloride in order, by means of the polarization-optical method, to observe and measure the distribution of stresses under elastic and plastic deformations, modeling the processes of plastic deformation of metals^(4–7). With silver chloride, work is being carried out on the simultaneous quantitative measurement of stresses and deformations in the elastic and plastic regions⁽⁸⁾, as well as of stresses produced by individual dislocations⁽⁹⁾.

However, up to the present time crystalline silver chloride has not been widely used in technology because of its low hardness and its extreme sensitivity to visible and especially to ultraviolet light. Under the action of light AgCl rapidly becomes exposed, i.e., is destroyed. The process of reduction of metallic silver (on which the use of silver halide salts in photography is based) leads to darkening and to a sharp decrease in transmission in the visible and infrared regions of the spectrum.

In order to make possible the use of silver chloride in infrared optics, a number of special coatings have been proposed^(10,11). However, most of them substantially reduce the transmission of light, increase its scattering and reflection, and, moreover, do not adhere firmly to the surface of the articles.

Fig. 1. Transmission spectra in the visible and infrared regions. a—AgCl without impurity: upper curve—unexposed, lower curve—exposed; b—with mercury impurity, unexposed; c—AgCl with mercury impurity, exposed

Figure 1: Fig. 1. Transmission spectra in the visible and infrared regions. a—AgCl without impurity: upper curve—unexposed, lower curve—exposed; b—with mercury impurity, unexposed; c—AgCl with mercury impurity, exposed

Thus, in order that silver chloride may be used in technology, it is necessary to improve its mechanical properties and eliminate its increased photosensitivity. Attempts to change the properties of crystalline AgCl have been undertaken repeatedly, but in these efforts attention was directed mainly to impurities that increase photosensitivity, or to mechanical properties (^{12–16}). The present work was undertaken by us with the aim of making crystalline silver chloride stable with respect to visible and ultraviolet light and stronger.

The crystals were grown by a modified Stockbarger method (¹⁷) in sealed glass (Pyrex glass) ampoules. The impurity was added to the main substance before sealing the ampoule and was thoroughly mixed. We grew AgCl crystals with impurities of Cu, Ni, Na, Zn, Cs, S, Hg, and others, in various concentrations.

(0.001–10.0 wt.%). As a result of the study it was established that impurities of Cu, Ni, Zn, Cs, and S increase photolysis; an Na impurity can greatly increase hardness; and an Hg impurity makes silver chloride stronger and completely stable with respect to visible and ultraviolet light.

Figure 1 shows transmission spectra, recorded on a Hitachi two-beam spectrograph, of pure AgCl crystals and crystals with an admixture of 0.1 wt.% Hg, exposed and unexposed. Exposure was carried out with an SVDSH lamp for 30 min at a distance of 100 mm. As is evident from the figure, the transmission of AgCl alloyed with mercury and irradiated did not change, whereas the transmission of the pure crystal decreased sharply as a result of irradiation.

Fig. 1. Transmission spectra in the visible and infrared regions.

a—AgCl without impurity: upper curve—unexposed, lower curve—exposed; b—with mercury impurity, unexposed; c—AgCl with mercury impurity, exposed.

It should be noted that the addition of mercury also improves the mechanical properties of silver chloride: the yield strength increases by a factor of 1.5–2, and the microhardness increases by 10–20% (depending on the impurity concentration).

Thus, as a result of alloying silver chloride with mercury, a new crystalline material for infrared optics has been obtained, stronger and harder than pure silver chloride, transparent up to 25 μ and stable with respect to the action of visible and ultraviolet light.

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Note: Figure translations are in progress. See original paper for figures.

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