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Investigation of the influence of the interference coating structure on the width of the high reflection zone (R>98%)

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Introduction. Currently, optical instruments that operate in two spectral regions are increasingly required. The mirrors used in their composition must provide high reflection, for example, in the visible and infrared regions of the spectrum. In order to preserve the transmitted energy, it is advisable that such mirrors have a reflection of more than 97%. The mirrors currently used in such devices are made from metals. Silver, aluminum or gold can be used as metals. Silver, as is known, is destroyed in the air due to its combination with sulfur, which leads to a decrease in the reflection coefficient. In the visible region of the spectrum, the energy reflection coefficient of gold does not exceed 96%, while in silver it is 90% [1], all this causes the need to create highly reflective mirrors based on dielectrics. Currently existing dielectric mirrors have high reflection in the range of no more than 800 nm, so the problem considered in the work is in demand and relevant.

The main part. Using multilayer interference systems on the surface of an optical element allows increasing the reflection coefficient from the interface between two media with different refractive indices. In this case, such media are glass and air. The reflection coefficient is increased by applying alternating layers made of materials with high and low refractive indices to the glass surface. Titanium oxide (n=2.40)[2] and magnesium fluoride were chosen as such layers. A matrix description of optical coatings was used to calculate the energy characteristics of the mirror.[3]

In the process of searching for the structure of the coating, several combinations of layers were considered.

1) Only increase the number of high and low refractive index film layers. As the number of layers increases, the maximum reflectivity of the coating will also increase, and the high reflectivity range will become wider. However, the increase in the width of the high reflection range is not significant.

2) Gradually increase the thickness of each membrane layer while increasing the number of layers. In this way, the increase in the maximum reflectivity of the coating is not obvious, but the width of its high reflection range is significantly widened.

Conclusion.

The above method simulated a coating system consisting of 50 layers of film. A high reflectivity range with a width of about 1700nm (450nm-2150nm) was obtained. 99% of the areas in the range had a reflectivity greater than 96%.

List of sources used:

1.Georg Hass, Rudolf E. Thun, «PHSICS OF FILM». New York and London, 1966.

2. Filmetrics. Refractive Index Database. https://www.filmetrics.com/refractive-index-database.

3. Georg Hass, Bedford, «PHSICS OF THIN FILM».IV New York and London, 1967.