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Optical design of a frontal lens of high aperture microobjective

5. ENGINEERING DESIGN

The frontal (forward) lens is one of the most difficult elements in the optical circuit of a microobjective. Such lenses cause maintenance of the real numerical aperture of an objective. In the majority of objectives for microscopes such lens is executed by the plano-convex, inverted plane to space of subjects [1]. Effective diameter of such lens can be less 1 mm, and the numerical aperture to achieve 1.42 at use oil or more at use of other kind's high refractive index immersions. Difficulties arise at manufacturing such lens when it is required to execute requirements of the drawing and to provide the necessary admissions on thickness and other design data. Other difficulties arise at fastening such lens in a frame. It is necessary to take into account, that frequently people working on a microscope, are mistaken at exact focusing on object, the frontal lens comes in contact to a sample and is exposed to the raised loadings. Therefore it should be well fixed.

In some publications such lens is in detail considered, its importance for a microobjective admits, recommendations on its manufacturing, fastening in a frame are given. However it is not considered, that the specified technological and technical difficulties are necessary for providing at a stage of optical design of such lens and a microobjective as a whole. For example, it is necessary to take into account how such lens will be fixed in a frame, and what real numerical aperture thus will be provided.

It is considered to be, that for achievement of the maximal numerical aperture the face-to-face lens should be made so that it was more, than a semicircle. That is the lens on sphere reaches further real equator. But there is a question on an opportunity of fastening of such lens without loss of the numerical aperture. It seems to us, the theoretical numerical aperture, in this case, cannot be provided. Moreover, even theoretically achievable numerical aperture is limited to a semicircle; thus to fix such lens

in a frame it is not obviously possible.

In this message the analysis of optical design and optics-mechanical designs of achromatical microobjectives working with oil is resulted, frontal (forward) lens is executed by the plano-convex, inverted plane to space of subjects. The conclusion that frequently such objectives do not provide the required numerical aperture, especially if it should be more, than 1.25 oil is made. There is it because technological and technical difficulties are not considered at a stage of optical design of such lens and a microobjective as a whole.

Recommendations on optical design of such lenses are resulted; mathematical parities for numerical values of thickness of a lens and other design data are resulted depending on values of the numerical aperture, working distance.

References:

[1] Handbook of optics, 1996.

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