Calculation of frontal components for microobjectives

Vinogradova O.A. *, PhD., Frolov A.D. **, Frolov D.N. *, PhD,
* Labor-Microscopes, St.-Petersburg
** National Research University of Information Technologies, Mechanics and Optics

Abstract: In this publication we present the analysis and geometrical calculation of construction parameters of frontal lenses high-aperture objectives for microscopes.

Generally, those objectives are working with immersion (in explain, cedar oil), which can increase resolution of the objective. For simple achromatic lenses are used single lens made of optical glass, whose refractive index is close to the refractive index of cedar oil. However, the adjustable parameters of such single lens are often not enough to build a flat-field lens in the image space. In this case, use double component. The refractive index of the first lens close to the refractive index of the immersion fluid, and the second lens is made of high-refraction crown. The difference in refractive indices allows us to correct the lens aberrations such as curvature of the image and the secondary spectrum.

However, this design solution is not efficient enough for high-aperture microscope objectives with aberrational correction planapochromatic type. This is due to the fact that its front lens element assumes a maximum value of the input numerical aperture. For oil immersion lens numerical aperture value reaches a value of 1.4. On how the component is able to reduce the front entrance numerical aperture at the highest possible degree of correction of aberrations such as curvature of the image and the secondary spectrum, depends on the possibility of correcting aberrations in the lens as a whole.

In the immersion microscope objective high-aperture there is also a problem in mechanical fastening the front frame component. This is especially difficult to do for the lens numerical aperture of more than 1.3-1.35 oil immersion. The form of the lens, which has contact with the immersion close to a hemisphere, securing it in a frame is not possible. Often used in a thin plane-parallel plate, which is attached to this lens. But this solution is not optimal. Double front lens design has some advantages. But it is also very difficult to secure such a component in a frame. We did an analysis of several optical calculations oil immersion lens, numerical aperture of which should be 1.4. We concluded that the technology of manufacturing of optical and mechanical components of frames can’t achieve such a value in a numeric aperture made lenses.

We propose to use triple lens component as the front element high-aperture immersion lens microscope. In this case, it is possible to achieve the maximum numerical aperture, properly secured in a front-end component of a mechanical frame, high-quality correction of aberrations and curvature of the secondary spectrum in the frontal component and the lens as a whole.