Experience of creating lenses for advanced researching in polarizing microscopy

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Abstract

Presents the results of the optical lens design for polarization of light microscopes, including to ensure that the special techniques. Sometimes such methods require the use of lenses similar increases in air and in immersion with iris aperture diaphragm.

Introduction

It can be argued that is objective determines the "power" of the microscope, as well as its consumer properties, it logical to start considering a description of the general concept of constructing optical designs microscope objectives. Mainly in microscopy have been developed lens microobjectives possessing several advantages over mirror and mirror-lens. This is expressed by the technological possibilities in their manufacture, they do not screening to eliminate other undesirable effects. If, however, describe the basic principles of design of modern systems of lenses of microscopes, we can see that they are based on several basic elements. The most important was the discovery of Lister that a two-lens plano-convex lenses are two pairs of conjugate points, free of spherical aberration. Considerable practical importance is the choice of the original for further design optimization, as well as the method of calculating the microscope objective. Issues related to the calculation of microscope objectives, a number of papers, for example, [1].

About compensation of chromatic difference of magnification in the lenses for microscopes

HRW (chromatic difference of magnification), as we know, there are field aberrations, characterized by the difference between the ordinates of the points paraxial image formed by the main beams of different wavelengths. Previously thought possible partial correction in the lens to HRW, to compensate for it by using a specially calculated eyepiece.

In different sets of microscope objectives residual value of HRW was 0.8-2%. Subsequent studies have shown that the presence of HRW in the intermediate image reduces the image quality of the microscope, because his compensation over the entire field is difficult, chromatic aberrations are usually stored. When the compensation system, they can be detected in the outer parts of the visual field in the form of more or less intense color fringe around the details of the object.

Lack of compensatory eyepieces, especially with an external pupil, is that because of their HRW, located in the plane of the intermediate image tags, dials, etc. outside the center of the field are represented with a color border, border color and width increases in proportion with the removal of these items from the axis. In addition, full payment by HRW with compensatory ocular difficult to achieve due to the fact that HRW compensating eyepieces usually varies considerably with the size of the image, while the value of HRW lenses virtually constant. In the case of the lens with the corrected image HRW achromatize across the field. In addition, there is a convenient opportunity to direct use of the intermediate image, for example, microphotography tasks for direct interface with digital image receivers or in other cases where it is desirable to operate without an eyepiece. Thus emerged the need for a microscope objective, well-corrected for residual chromaticity increased.

Immersion lens microscope

Separately, we should stop on the using of the front lens immersion microscope objective. Application of immersion, as is known, allows you to fundamentally solve the problem of increasing the numerical aperture of the lens. In practice, however, fails to fully utilize this advantage, since an increase in aperture will inevitably entail a significant complication of subsequent elements of the microscope objective. Achromatic lenses are sufficient for the requirements of high technology in achieving the maximum aperture, however, image quality, given by the achromat, worse in comparison with lenses with a correction.

In terms of optics - calculators lens' optical system to create immersion microscope objectives having specific difficulties. In comparison with the "dry" lens, the immersion is greatly reduced the difference between the refractive indices of the two contacting media. However, the desired conditions of the front element when the difference is maximum, as is the case when operating the lens from the air. There are some provisions in the development high-refractive optical material having specific physical and chemical properties. In the achromatic microscope objective so far widely used plane-convex lens front, turned the plane to the immersion. Traditionally they are made from a material whose refractive index is close to the refractive index of the immersion fluid. However, when such construction is not possible quality correcting some aberrations in the lens as a whole (the curvature of the image, and astigmatism). To correct these aberrations in a flat-field images using glued wheel element whose action is equivalent to that of the meniscus facing concavity of the lens (as in "dry" lens), the first surface facing in the immersion. From the object in such a meniscus glued plano-convex lens whose refractive index is equal to the refractive index of the immersion. The use of such elements as the front lens in immersion lenses can significantly affect the correction of the lens as a whole. It remains to add that here the difference of the two contacting media should be maximum; therefore, along with an increase in the refractive index of the meniscus, it is appropriate and possible reduction of the refractive index of plano-convex lens. It is no exaggeration to say that the main problem to date in obtaining a large increase in the immersion objective is to achieve technologically secured value of the first radius of the meniscus. One way is to increase the refractive index of the element when under the same conditions correct astigmatism curvature is reduced.

Features of special lenses for polarization researching

Observation of objects in the polarizing microscope can be carried out in various ways. Along with the spread may also apply special methods of observation, which, for example, are the focal screening methods, phase contrast, and others.

Methods focal screening used in the study of immersion for comparison of the refractive indices of the object and its surrounding immersion medium. Thus, depending on the difference between the refractive indices of two media at the edges of the object to the color effect. Lenses must be able to carry out observations using two methods, the focal screening, called a ring and a central screening. To this end, all lenses should have the aperture iris diaphragm, disposable in the back focal plane, and each of the "dry" lenses must be paired with the same lens numerical aperture, but is designed to work with the immersion. Table 1 shows the optical scheme and the basic specifications of lenses for light polarizing microscope, realizing the special polarization techniques.

Conclusion

Presented lenses can complete such items as workers, laboratory and research polarizing microscope.

A distinctive feature of these lenses, except for the use of optical components without proper stress is the presence of irises aperture diaphragm, which is useful when implemented in a polarizing microscope, one of the focal species method of screening. Lenses have the same increase in air and immersion media.

References

1. D.N. Frolov Synthesis of optical systems, optical lens microscope objectives Magazine, Volume 69, № 9, 2002, p. 16-20

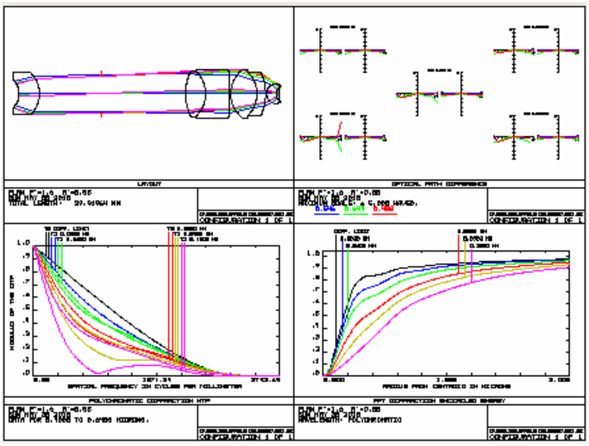
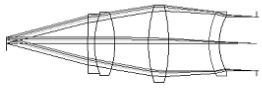
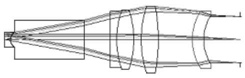
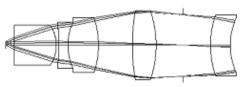
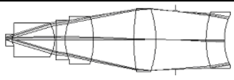
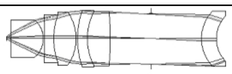
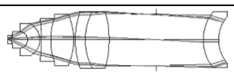


Figure 1. Characteristics of image quality microscope objective F '= 1.6mm A = 0.85

Table 1. Lenses for polarizing light microscopes

Characteristics		Principal optical structure
increasing x aperture, type of correction	Free working distance, mm	
height 45mm, infinity tube length, F'tl=160mm, 2y'≈20mm, achrostigmat		
1) 10x0.25	12.10	
2) 10x0.25 oil	1.00	
3) 20x0.45	1.20	
4) 20x0.45 oil	1.00	
5) 40x0.65	0.50	
6) 40x0.65 oil	0.40	
7) 100x0.85	0.23	
8) 100x1.25 oil	0.28