Experience of objectives for digital microscopes

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1. Abstract

The theoretical and practical aspects of optical systems of lenses for digital microscopes, in which the image of the object is projected onto the electronic receiver. The results of optical calculation, creation of optical-mechanical design, development, manufacturing technology of lenses with aspheric surfaces of lenses for digital microscopes.

2. Introduction

Objective is a main element in digital microscope. From his technical and consumer characteristics depends how well you can replace conventional microscope in which images of study conducted by an observer through the eyepiece. The digital microscope observation through the eyepiece may be absent or replaced by a projection of the electronic receiver for the formation and monitor for imaging. The optical system of digital microscope as well as in a conventional microscope can be used multiple lenses with different parameters of input numerical apertures and linear fields on the object. However, more appropriate to use instead of several lenses, only one in which both realized the advantages of low magnification lens (allowing to explore a large linear field at the site) and "strong" high aperture lenses possessing maximum resolution. Only in this case, the full use of such technical capabilities as a receiver of its resolving power and linear size.

3. Overall calculation lens digital microscope

Along with the traditional requirements for a congruent image of the object must perform specific conditions, such as ensuring the relationship between the parameters of the lens and the receiver. The main characteristics of microscopes (conventional and digital) are the resolving power and linear field. It is known that the resolving power of the lens due to its input numerical aperture. If we assume that the resolution of the receiver is limited by the size of a single "elementary" structure - a pixel, we can define the output numerical aperture of the lens. For a standard pixel size of about 3 microns output numerical aperture of the lens is approximately 0.10. Linear field, which is considered optimal in microscopic studies is approximately 18 mm, therefore, advisable to use the unit size of 1 inch.

4. Aberrational calculation lens digital microscope

If the object being studied non-self, in the optical system using a digital microscope lighting system, then the correlation parameters of the receiver, especially non-monochromatic, with the parameters of the light source of the microscope requires special consideration. This calculation represents a kind of convolution of two functions, as input data used to calculate the spectral characteristics of a particular receiver and the data of the spectral composition of radiation in a particular light microscope. The results of calculation can be used for designing the optical system of the lens. Such residual aberration of the optical system as the curvature, astigmatism and distortion in the lens for digital microscopes must be corrected with great care. Necessary to achieve the plan apochromatic correction of aberrations in the extended from 400nm to 1000 nm spectral range.

5. Technology of manufacturing non-spherical surfaces in the lenses for digital microscopes

The results of the aberration calculations showed that the use of only spherical surfaces can not provide the required characteristics of image quality. Therefore, we used non-spherical surface of the second beam along the cemented component.

6. Conclusion

We made optical calculation, carried out the design and developed a technology to produce objectives for digital microscope. The characteristics of this objective include:

- Linear magnification 10x
- Numerical aperture in object space 0.90
- The lens is designed to work with the drug (biological), covered with cover glass thickness d = 0.17mm
- Free working distance of the lens approximately 0.45mm
- Linear field in image space, 16-18mm
- Implemented telecentric path of the rays

Designed lens can be used in a digital microscope, and replace the whole set of objectives (with a linear increase of 5, 10, 20, 40 and 100x). The advantage of the developed objectives, the achievement of

maximum linear field and numerical finishing within a single design. The optical scheme developed by the lens is shown in Figure 1.

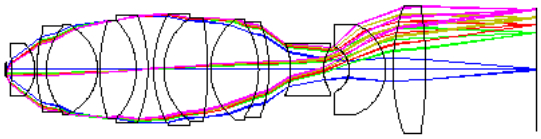

Fig. 1