Optical design of objectives – LCF PlanFluor Pol for 27 mm observation in the polarizing microscope

Dmitry N. Frolov*[a], Olga A. Vinogradova[a], Vladimir N. Frolov[b], Pavel S. Vakulov[b]
[a]Project Labor-microscopes, [b]AME Enterprise Russia, Saint-Petersburg,
* fronda@list.ru; phone +7 812 933 25 78; labor-microscopes.ru

Abstract: The obtaining a large field for visual observation under a polarizing microscope is still a technological challenge. Objective is the most difficult element of the optical system. It should be clear in relation to the chromatic aberration, but also have an increased numerical aperture.
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1. Introduction

At least two parameters, which we would like to improve, if we talk about modern objectives for polarization research. Basically, it refers to budgetary objectives, which can use in laboratory and working models of a polarizing microscopes. Linear ocular field of microscopes (and objectives) should be increased. Also the numerical aperture of lenses must be increased. Both of these parameters significantly affect the quality of the studies on the microscope. But we have to make correction of some types of aberrations [1].

2. Correcting chromatic aberration

Correcting chromatic aberration is very important in polarization microscopy. Polarizing objects having different colors for different parts and fragments. For proper identification requires a good color reproduction without distortion. The primary chromatic aberration is corrected always. Until recently, in the polarizing objectives (especially budgetary) the secondary chromatic aberration was not corrected. Of course, this is a very big disadvantage, especially if you try to do surveillance on a large field. Ocular linear field of 27 mm gives a new quality of visual observation on a polarizing microscope. Therefore, we develop objectives that have a secondary aberration chromaticity corrected (LCF – lateral color free). We also began to make a decrease aberration secondary spectrum that can severely distort the color.

3. Correction of curvature of the image

Correction of curvature of the image is important because the polarization objects usually flat. It is necessary to avoid the appearance of non sharpness and reducing the contrast in the image during projection through the objective. Especially, it concerns a large magnification objectives. Also very good to be corrected astigmatism and coma in inclined beams. Ocular linear field of 27 mm gives a new quality of visual observation on a polarizing microscope. Therefore, we do polarisation objectives which are corrected on the image curvature aberration, astigmatism and coma. We also began to make some reduction in the distortion aberration, which can interfere with measurements of image fragments.

4. Specifications of optical design

We made optical designs of set of objectives for polarizing researches. One of them is PlanFluor Pol 100x/1.37 oil immersion, similar others objectives, has well correction of chromatic (436-644 nm) and curvature aberrations. Next drawing show it.

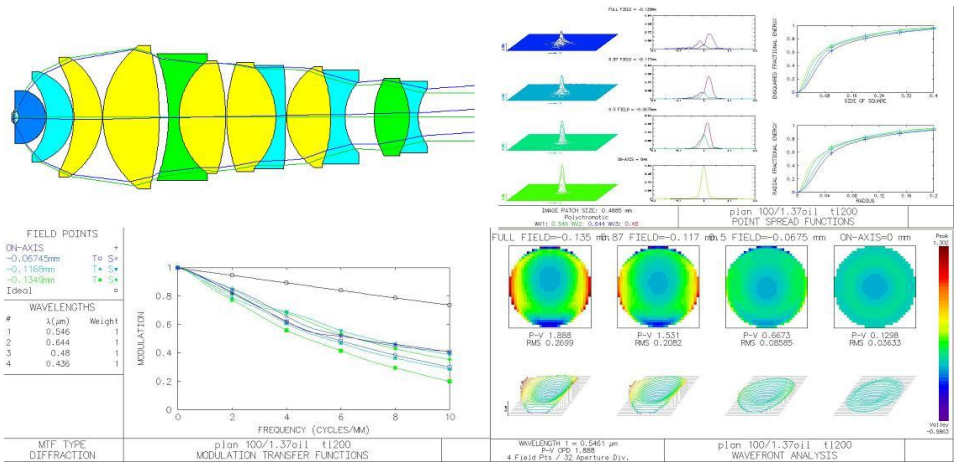
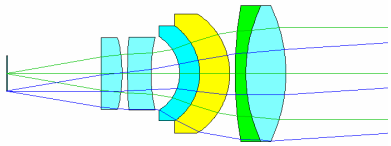
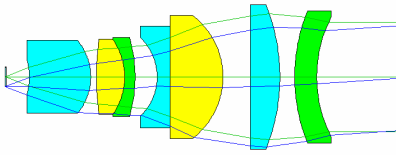
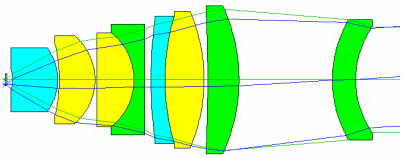
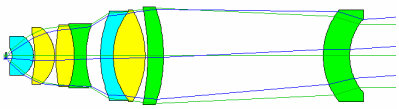
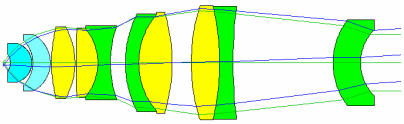
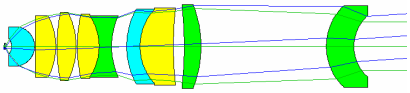
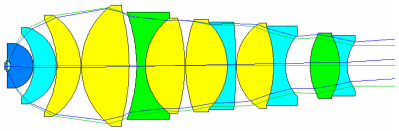


Fig. 1. Optical design and graphics aberrations of objective 100x1.37 Oil immersion

The table 1 shows the main technical parameters and basic optical layout of objectives. This design for an infinite length of the microscope tube, using additional focusing system F = 200 mm.

Table 1. Main technical parameters and basic optical layout of objectives

Magnification	NA	WD (mm)	F' (mm)	R (μm)	DF (μm)	FOV on object (mm)	FOV on image (mm)	The principal optical layout
5x	0.17	13.7	40.0	1.96	11.5	5.4	27	
10x	0.37	2.60	20.0	0.90	2.43	2.7	27	
20x	0.67	0.48	10.0	0.50	0.74	1.35	27	
40x	0.77	0.41	5.0	0.43	0.56	0.68	27	
50x	0.87	0.40	4.0	0.38	0.44	0.54	27	
60x	0.87	0.30	3.3	0.38	0.44	0.45	27	
100x	1.37 Oil	0.11	2.0	0.24	0.18	0.27	27	

Analysis of optical lens systems shows that the negative components are used. The negative component is located in front of the objective in the form of a double cemented meniscus, that faces the convexity of the to object. It is known that such a component is the strong compensator for spherical aberration and sferochromatism. He helps to reduce the curvature and astigmatism in the image too. Also used negative meniscus located at the end of the optical circuit. They can be single or cemented.

5. Conclusion

Using the original optical systems for objectives – has allowed to reach a new technological level. We have made optical design of objectives for a microscope that have correction PlanFluor for the polarization studies. Also, linear ocular field reached 27 mm, the numerical aperture of the objectives is also increased. Lateral chromatic aberration totally corrected (LCF correction), secondary spectrum is reduced.

6. References

[1] Optics – Handbooks, manuals, etc. 2. Optical instruments – Handbooks, manuals, etc. 1. Bass, Michael. II. Optical Society of America. QC369. H35 1995, 535 – dc20 94-19339 CIP.