



# Optical designs of the objectives for special studies in polarizing microscope

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

**1. Introduction.** It is believed that objectives for microscopes should have unified technical and consumer parameters. Moreover, the number of formal signs for unification is quite large. For optical design it means, that it must meet certain requirements for optical systems of objectives, such as:

- infinite optical length of the tube,
- observance of telecentric ray path,
- ensuring the matching of the parameters of the entrance and exit pupils, the constancy of their position in all the objectives of the selected set,
- observance parfocal, paracentric parameters of objectives, etc.

## 2. Optical designs of some sets of objectives.

The practice of polarization microscopy methods shows that it is necessary to use two types of objectives, the first small magnification (overview), with which you can select the most interesting fragment for research, this case real object surface plane may be used. And, especially valuable are objectives, linear magnification of which is close to 1x, or even less. In routine work, objectives with linear magnifications of 2.5x and 5x, 10x can also be used as survey objectives.



Image of a "point" diaphragm of condenser



Image of the ring condenser diaphragm



Relative position of the iris diaphragm of the objective and the image of a "point" diaphragm of the condenser in the exit pupil of the objective during ring screening



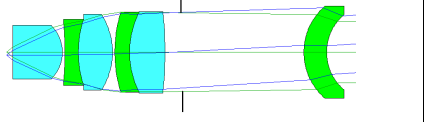
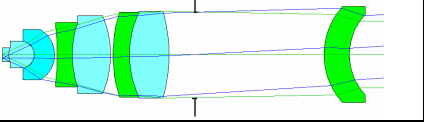
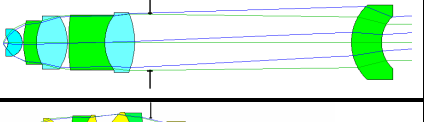
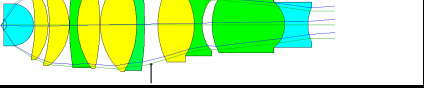
Relative position of the iris diaphragm of the objective and the image of a ring diaphragm of the condenser in the exit pupil of the objective during central screening

Figure 1. Types of diaphragms that are used in the focal screening methods.

The second kind of objectives are objectives with an linear magnification of 20x, 40x, 60x, or even 100x. In the orthoscopic microscopy real image using for research. In the conoscopic microscopy output pupils of objectives of which an interference pattern is formed are using for research. A prerequisite is the precise focusing of the objective on the surface of the object under study, as well as the observance of the condition of the telecentric ray path (i.e. the coincidence of the position of the investigated surface of the object with the front focal plane of the objective).

Table 1. Main technical parameters of special objectives for polarizing microscopes.

Magnification	NA (max)	WD (mm)	F' (mm)	R (μm)	DF (μm)	FOV on object (mm)	FOV on image (mm)	Remarks	The principal optical layout
0.8x	0.015	3	200	-	-	14	11.2	PlanAchro	
2.5x	0.04	17.7	64	-	-	8.0	20	PlanAchro	
10x	0.25	12	16	1.33	2.66	2.0	20	PlanAchro	
10x	0.25 oil	1.0	16	1.33	2.66	2.0	20	Stigma Chromat	
20x	0.45	1.0	16	0.74	1.64	1.0	20	PlanAchro	
20x	0.45 oil	1.0	16	0.74	1.64	1.0	20	Stigma Chromat	

40x	0.65	0.52	4	0.51	0.79	0.5	20	Stigma Chromat without coverglass	
40x	0.65 oil	0.40	4	0.51	0.79	0.5	20	Stigma Chromat	
100x	0.85	0.15	1.6	0.39	0.46	0.20	20	PlanAchro without coverglass	
100x	1.32 oil	0.10	1.6	0.25	0.19	0.25	25	PlanFluor	

**3. Conclusion.** Presented objectives can complete such items as workers, laboratory and research polarizing microscope. A distinctive feature of these objectives, except for the use of optical components without proper stress is the presence of irises aperture

diaphragms, which is useful when implemented in a polarizing microscope, one of the focal species method of screening. Objectives have the same linear magnifications in air and immersion media.