Optical designs of non standard objectives for use in biological microscope

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Abstract. The results of optical design of non-standard objectives for biological light microscopes are presented. Considered objectives, which use water immersion, including. Also, objectives for the fluorescence use.

1. Introduction. Different methods of research using light biological microscopes require the presence of a whole range of different elements of the optical element base. The main optical element is the objective, which has the more perfect optical correction then other elements of optical system of microscope. Based on the conditions in which the microscope works, what kinds of research it solves, it is necessary to use various objectives with varying degrees and types of aberrations correction, using one or another immersion, calculated to work in this or that spectral range.

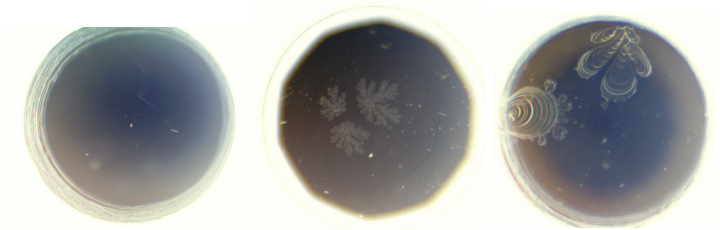


Figure 1. Photographs of some typical kinds of lenses “gluedless”.

2. Optical designs of different objectives. The most important component of increasing the informativeness is an increase in the numerical aperture of micro-objectives. The numerical aperture of the objective in the space of objects determines the resolving power of the microscope, in the image space significantly affects the energy parameters of the microscope. Of particular interest is the possibility of obtaining low magnification objectives with large input numerical apertures. In objectives with increased numerical apertures, the correction of spherochromatic aberration is especially laborious, since its higher orders increase nonlinearly with an increase in the relative aperture of the objective.

Table 1. Main technical parameters and basic optical layout of 20x/0.75 and 40x/0.85 objectives.

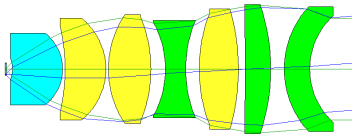
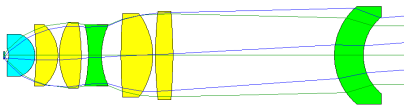
Magnification	NA	WD (mm)	F’ (mm)	R (µm)	DF (µm)	FOV on object (mm)	FOV on image (mm)	Remark (screw)	The principal optical layout
20x	0.75	0.45	8.0	0.44	0.59	1.25	25	0.8” or more	
40x	0.85	0.20	4.0	0.39	0.46	0.625	25	0.8” or more	

Table 2. Main technical parameters and basic optical layout of water immersion objectives.

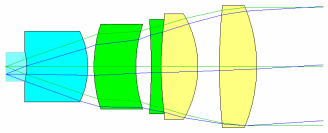
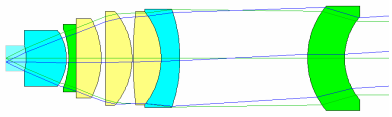
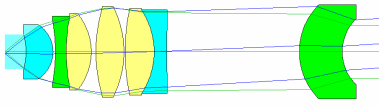
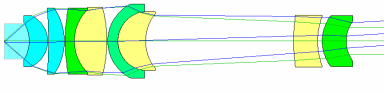
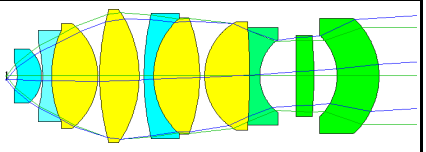
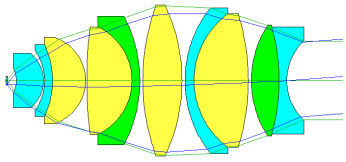
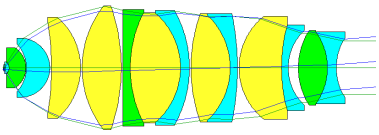
Magnification	NA	WD (mm)	F’ (mm)	R (µm)	DF (µm)	FOV on object (mm)	FOV on image (mm)	Remark (screw)	The principal optical layout
10x	0.50 wi	2.1	16	0.67	1.33	2.0	20	0.8” or more	
20x	0.60 wi	2.1	8	0.56	0.93	1.0	20	0.8” or more	
40x	0.85 wi	2.1	4	0.39	0.46	0.5	20	0.8” or more	
100x	0.90 wi	1.9	1.6	0.37	0.41	0.2	20	0.8” or more	

Table 3. Main technical parameters and basic optical layouts of objectives with increased output numerical apertures.

Magnification	NA	WD (mm)	F' (mm)	R (μm)	DF (μm)	FOV on object (mm)	FOV on image (mm)	Remarks	The principal optical layout
16x	0.80	1.0	10	0.42	0.52	1.56	25	PlanAchro Coverglass d=0.17 mm h=60 mm	
20x	0.80	0.9	16	0.42	0.52	1.25	25	PlanApo Coverglass d=0.17mm h=45 mm	
40x	1.20 wi	0.10	5.0	0.28	0.99	0.78	25	PlanApo Coverglass d=0.17 mm h=60 mm	

3. Conclusion. Presented variants of non-standard objectives for use in biological microscopes may allow carrying out studies that are impossible with the use of standard objectives. Some objectives allow you to work outside of laboratory conditions. Some objectives are specifically designed to work with water immersion or physiological solution. Other objectives have an increased numerical aperture when middle values of linear magnifications are reached.

A set of non-standard objectives is also offered, which have a high transmission in a wide spectral range. Some aspects of the optical and mechanical design of nonstandard objectives for biological microscopes are considered, and the results of this engineering work are presented.