Use of opportunities of contact microscopy. Optical design.

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SPIE. OPTICS+ OPTOELECTRONICS Prague, Czech Republic, 1 - 4 April 2019

Abstract. The study of biological objects using a light microscope is one of the main methods of diagnostic practice in many areas of natural science. Most modern methods of researching objects using a light microscope include preliminary preparation of objects. However, in this case it is impossible to achieve a high degree of reliability of information about the object under study.

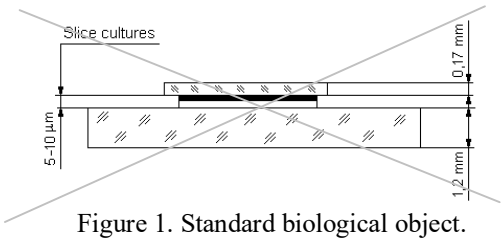


Figure 1. Standard biological object.

1. Introduction. Figure 1 shows the object to be studied with a biological microscope. In a general case, it is a specimen, i.e. a thin slice of matter or a smear glued with one of its side to the object plate with the opposite one glued up with the coverglass.

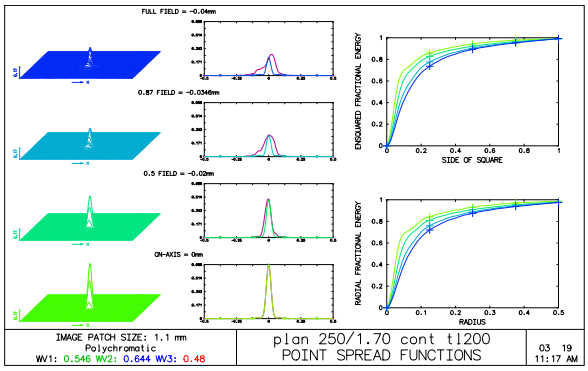
However, it becomes impossible to achieve a high degree of reliability of information about the object under study, since it is no longer alive. In addition, the parameters of the dye, glue and cover glass also contribute some information to the image on the microscope.

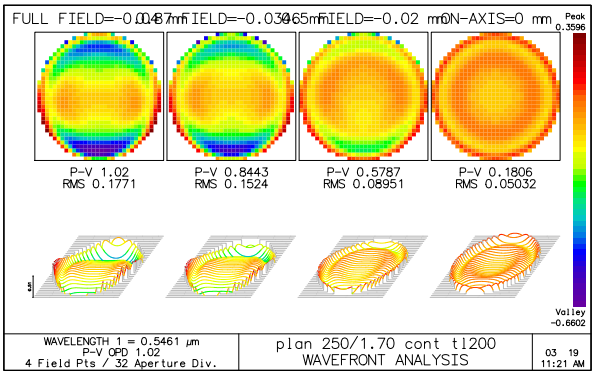
2. Description. Naturally, the main element of the optical system of such a light microscope is its projection system, namely, the objective. The objective must provide the ability to study the object in its in-life state, working with the object in direct contact, integrating into the structure of the object. It is known that many types of biological objects for 80-90% consist of water or substances close to water. To design the optical system of a microscope, it is necessary to take into account such parameters as the values of the refractive index and spectral characteristics. However, for some types of matter these parameters may differ. One of the original engineering solutions in building a light microscope can be the use of so-called "contact" objectives; old "contact" objectives in figure 2 are presented.

Figure 2. Old types of "contact" objectives.

Lens: plan 250/1.70 cont tl200
Object num aper 1.700000 Image height 10.000000 Primary wavln 0.546070

SRF	RADIUS		THICKNESS		APERTURE RADIUS		GLASS		SPECIAL
OBJ	0.000000		0.000100		0.039990		H-ZLAF55D		
AST	0.000000		1.400000		0.040000	A	H-ZLAF55D		
2	-1.010000		0.149720		1.010000		AIR		
3	-2.608000		2.600000		1.650000		CAF2		
4	-2.608000		0.200000		2.590000		AIR		
5	-300.000000		1.400000		3.690000		ZLAF1		
6	9.480000		4.900000		4.280000		CAF2	P	
7	-5.160000		0.100000		4.710000		AIR		
8	13.600000		1.300000		4.920000		H-ZF6		
9	10.758000		5.400000		4.720000		CAF2	P	
10	-5.916000		1.600000		4.600000		ZLAF1	P	
11	-14.900000		0.100000		5.140000		AIR		
12	6.066000		5.500000		5.340000		CAF2	P	
13	-11.290000		1.600000		4.820000		ZLAF1	P	
14	24.900000		2.000000		4.230000		AIR		
15	5.960000		4.000000		3.630000		CAF2	P	
16	2.500000		2.700000		2.170000		H-ZF6	P	
17	1.260000		4.500000		1.070000		AIR		
18	-1.820000		4.500000		1.220000		ZLAF1	P	
19	-4.178000		200.000000		2.770000		AIR		
20	-36.100000		14.000000		14.880000		K9		
21	-43.560000		3.000000		17.460000		AIR		
22	377.100000		15.000000		17.940000		CAF2		
23	-81.500000		3.000000		18.350000		AIR		
24	221.300000		17.000000		18.050000		CAF2		
25	-72.000000		3.000000		17.180000		H-LAK2		
26	0.000000		199.993929	S	17.100000		AIR		
IMS	0.000000		0.000000		10.000000				





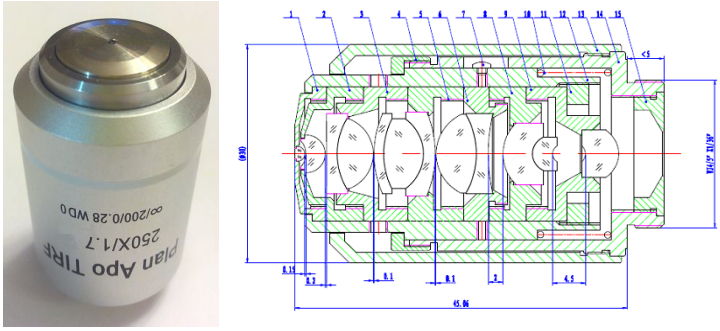
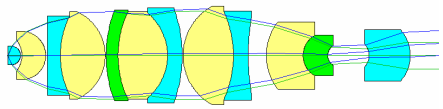
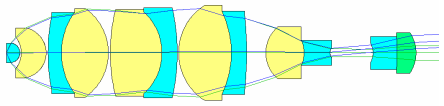
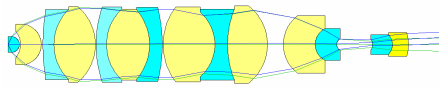


Figure 3. Parameters of design and the aberration correction graphs for objective 250^{x} / 1.7.

Table 1. Main technical parameters and basic optical layout of new “contact” objectives.

Magnification	NA	WD (mm)	F’ (mm)	R (μm)	DF (μm)	FOV on object (mm)	FOV on image (mm)	Type of correction	The principal optical layout
250^x	1.7	0	0.8	0.196	0.115	0.08	20	PlanApochromat	
500^x	1.7	0	0.4	0.196	0.115	0.04	20	PlanApochromat	
500^x	1.7	0	0.4	0.196	0.115	0.04	20	PlanPolyApochromat	

3. Conclusion. For the study of some microscopic objects requires optics that differs from conventional optics, which is used in most light microscopes. Of course, such objects need to be studied in the "in vivo" state, since, by killing them (the technique of conventional microscopy with sample preparation), we will lose a lot of useful information; only living cells and only in natural habitat can give reliable information about them.

Specially designed objectives provide maximum resolution and linear magnification; this helps to effectively identify objects that are examined under the microscope. The objectives we offer today implement the concept of ultra-high linear magnification (250^x and 500^x) and maximum numerical aperture; aberration correction types are PlanApochromat and PlanPolyApochromat the effective working spectral range is 355-800 nm).