



Optical design of budget objectives for mass production microscopes

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SPIE PHOTONICS ASIA Beijing, China, 11 - 13 October 2018

Abstract. The results of optical designs of objectives for budget light microscopes are presented, including for providing special methods of contrasting. For the design, original optical constructions are applied.

1. Introduction. In budgetary microscopy, the volume of which occupies at least 75% of the market, the "first generation" objectives, proposed by Abbe many decades ago, are used. These are achromatic objectives, the aberration correction of which is far from perfect; moreover, it is full of compromises. Attempts to modernize the optical systems of Abbe objectives have not been undertaken, more than 100 years, since their optical systems seemed to be as simple and cheap to manufacture as possible. In Russia, the engineers of our project made optical designs, and also produced objectives in which, with a simpler optical system, it was possible to maintain the quality of aberrational correction of Abbe objectives.



Figure 1. Images of finite tube objectives.

2. Optical designs of different objectives.

The first group is the objectives of finite tubuslength standard magnifications. Two types of aberration correction are present: LCR Achromat and LCF PlanAchromat. The second group is the objectives of infinite tubuslength standard magnifications. The type of aberration correction is LCF PlanAchromat.

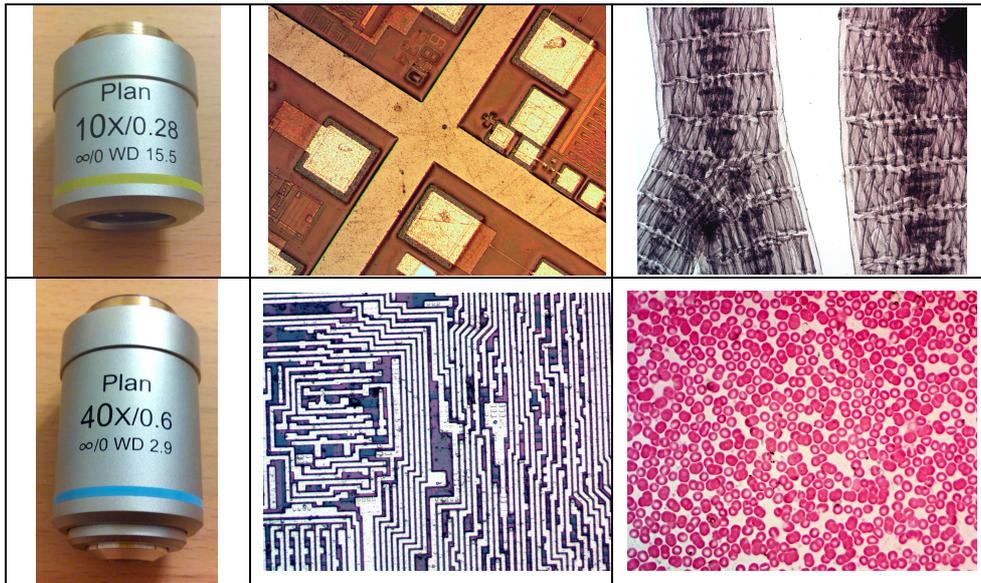


Figure 2. Objects without and with a coverglass – images through new objectives.

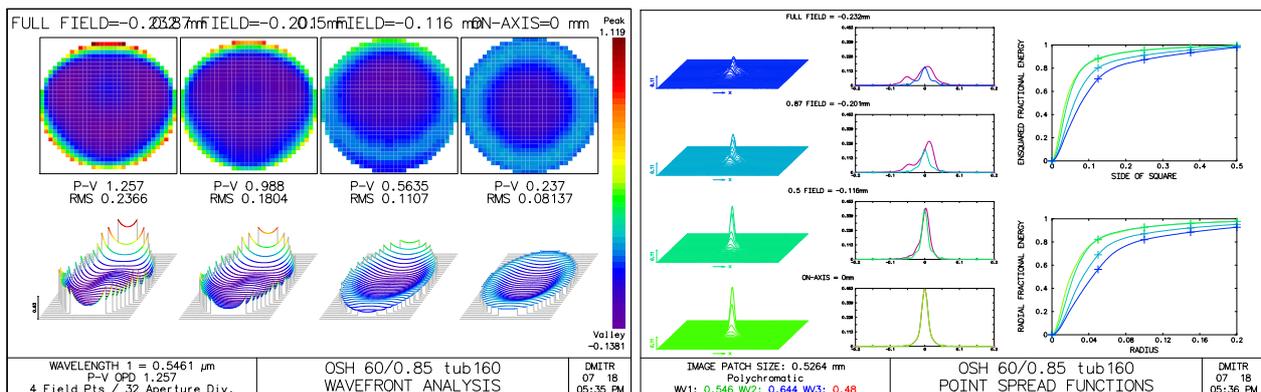


Figure 3. Aberration correction graphs for objective 60x / 0.85 LCF PlanAchromat.

Table 1. Main technical parameters and basic optical layout of new objectives for finite tubuslength.

Magnification	NA	WD (mm)	F' (mm)	R (μm)	DF (μm)	FOV on object (mm)	FOV on image (mm)	The principal optical layout
4	0.13	15.2	31.5	2.6	20	5.0	20	
10x	0.30	11.2	15.05	1.12	3.73	2.0	20	
20x	0.65	0.48	8.37	0.52	0.79	1.0	28	
40x	0.70	0.52	4.49	0.48	0.69	0.5	20	
60x	0.85	0.20	2.79	0.38	0.43	0.33	28	
100x	1.20 water	0.12	1.79	0.28	0.23	0.2	20	
100x	1.3 oil	0.12	1.69	0.26	0.20	0.2	20	

3. Conclusion. Presented objectives can be used in the manufacture of microscopes of the budget segment. New objectives are characterized by high quality of the image, which is ensured by the effective concept of aberration correction, when corrections are subject to such aberrations as image curvature and lateral chromaticity. As a result, the image quality is significantly improved in comparison with most of the budget objectives that are on the market today.

In the near future, we can expect a "change of generations" of objectives, which will be used in budget light microscopes. In turn, the inclusion of new optics in the composition of budget microscopes can give a positive impetus to the use of modern positioning devices for the object placing, as well as image processing based on digital technologies.