



Designing a teaching grade phase contrast microscope on an optical bench

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In this piece of work, we demonstrate design of a simple Phase Contrast Microscope (PCM) on an optical bench, which can be used in undergraduate optics laboratories to teach the underlying principles. Prof. F Zernike was awarded the Nobel Prize in 1953 for his discovery of the phase contrast principles [1]. Although the PCM imaging technique is quite popular for research studies of transparent biological samples, its working principle is quite interesting for students of optics.

The basic principle of a PCM is to convert the phase changes produced by any transparent object, which differs only slightly from its surrounding, into amplitude changes in the final image [2]. Instead of the usual upright microscope, we have built a PCM test set up on an optical bench. We have used a 10X phase contrast objective (NIKON make) which includes $\lambda/4$ phase ring, a matching phase annulus and some other standard laboratory equipment. The test set up is shown in Fig.1. We have used a red laser as the light source. One can also use a suitably collimated white light source. The test set up was used to image typical biological samples (an onion peel) and the preliminary results are reported here as shown in Fig. 2. The image was taken by a smartphone camera placed close to the eyepiece. The internal cell structures with membranes can be seen. The inset in Fig. 2 is an image taken for the same sample using a commercial PCM with 10X objective, just for comparison.

We are currently trying to improvise the set up and image physical samples like single and multimode fibres, transparent thin films etc. and use it as an undergraduate optics experiment.

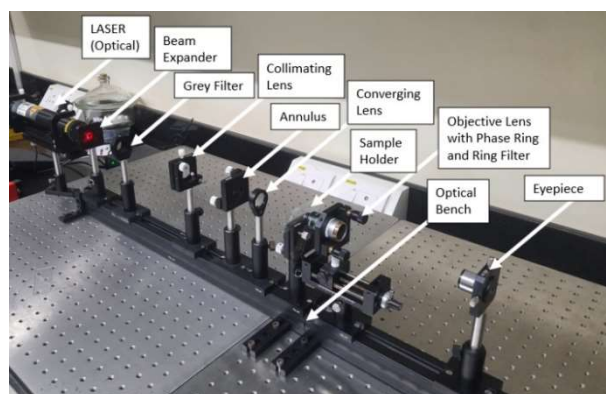


Figure 1: Experimental set up for PCM

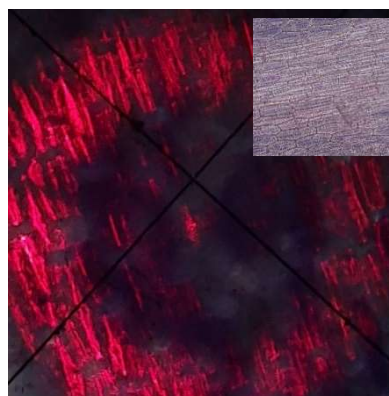


Figure 2: Image of an onion peel using our set up. Inset shows image of the same sample using a commercial PCM with a white light source

References:

1. F. Zernike, Phase contrast, a new method for the microscopic observation of transparent objects, *Physica*, **9**, Issue 7, 686 (1942)
2. F. A. Jenkins & H. E. White (1981). *Fundamentals of Optics*. McGraw-Hill, Inc. ISBN 0-07-085346-0.