Nanoobjects microscopy

Extending the Depth of Field for a Microscope System

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Wavefront coding technology is one of widely used methods to extend the depth of field in recent years. By applying a specially designed phase mask at the pupil plane, the whole system is insensitive to object distance. By arranging a specially designed phase mask between the objective and the tube lens, the previous time consuming work of frequently changing the structure of the objective can be avoid, the optical and mechanical structure will remain the same except adding the phase mask [1]. It is cost effective and more flexible in comparison with the previous method which alters the structure of the objective.

Thanks to the newly developed film fabrication technology, the wavefront coding can use phase mask instead of amplitude mask. Therefore, it does not sacrifice resolution or illumination compared to other methods such as optical pupil apodization. Through laser direct-write photoresist patterning and subsequent reactive ion etching on a germanium substrate [2], it is possible to realize a diffractive lens with ten times depth of focus improvement over a conventional infrared lens of the same numerical aperture preparation.

The current image correction method uses a deteriorating phase plate, followed by the energy consuming Post Digital Image Processing, in order to obtain a good image quality. Without more processing, this method would only reach a very poor visual quality caused by the necessary phase deteriorating plate. In other words, the conventional methods must go through a strong deteriorating phase plate before processing to fix the muti-focusing problem [3]. This is to ensure that all images have approximately the same mis-focus, before beginning the Post Digital Image Processing. The same optical transfer functions make the post digital image processing manageable. Therefore, the deteriorated images can be fixed by a same inverse method digitally. This post-processing generally requires at least two dimensional forward Fourier transform and inverse Fourier transform and hence is computationally intensive and energy costy. In contrast, the new proposed method would use an improving plate instead of the deteriorating plate, thus, obtaining quality acceptable results presented below without any energy consumption.

Fig.1 Optical Transfer Function comparison on their magnitude: (left) without phase plate ((right) with the proposed phase plate.

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