

# MULTI-SPOT ILLUMINATION FOR SUPER-RESOLUTION MICROSCOPY

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The multi-spot illumination is discussed as a *structured illumination* for optical microscopy with visible light. It is generated directly by *interferences without any lens*. Therefore pinhole arrays with  $\mu\text{m}$ - and  $\text{nm}$ -holes are used manufactured by photolithography.

The holes have diameters of 350 nm ... 1.2  $\mu\text{m}$ . Their technology, the optical performance and their limits are presented. For typical multi-spot arrays (4 x 4 pinholes with distances of 4 ... 50  $\mu\text{m}$ ) we reach for the array mask a state of the art *contrast* of  $10^4$ . The contrast is further increased by a factor of  $10^2$  by pre-imaging the multi-spot array by a beam already structured to a multi spot beam with a diffractive optical element (DOE). The array mask generates light spots for a structured illumination in the object plane. If the diameter of the holes approaches the wavelength, the aperture of the illumination is increased and the *spot size* approaches half of the wavelength. By an additional scan the spatial resolution in microscopy can reach  $\lambda/4$ . A different structured illumination of samples is known as a technique for sub diffraction optical microscopy [1]. Applications of the multi-spot illumination in optical microscopy could be a parallelization in laser scanning microscopy, too.

In the figures (c) and (d) an example is given, where the *diffraction limit* of a microscopic lens is overcome by using a directly generated structured illumination. The coherent multi-spot illumination is also applied for *digital inline holographic* microscopy. Examples are given of imaging with *increased field of view* by the factor of more than 9 [2-4].

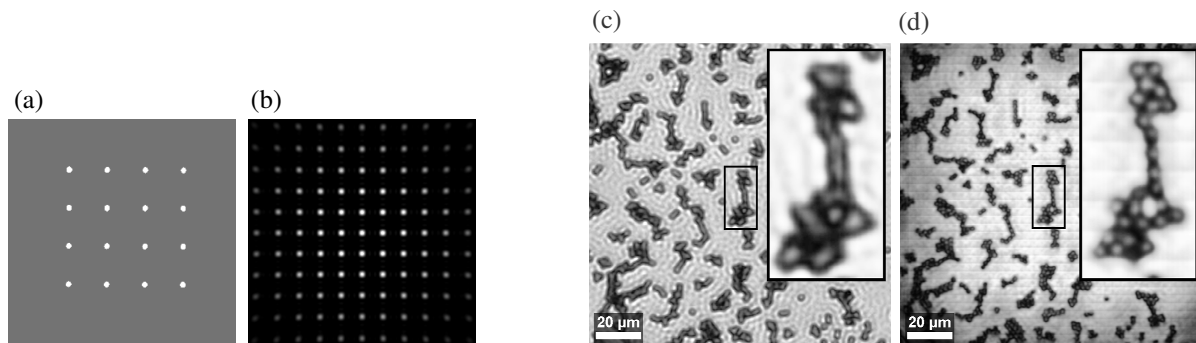


Figure: Microscopic image of a pinhole array (4 x 4 holes, diameter 1.2  $\mu\text{m}$ , period 30  $\mu\text{m}$ ) (a), interference spots as structured illumination (additionally interference contrast enhancement by the factor 350) by coherent light (b) and picture of 2  $\mu\text{m}$  PMMA-beads taken by a microscope with a lens (10x / NA = 0.2) (c). The same object imaged by a multi-spot illumination (b) and a scan (d). The resolution overcomes the diffraction limit of the lens.

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