Large 1D spot array generator implemented as kinoform detour-phase hologram

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Multiple beam splitter gratings have a variety of applications in multiple imaging, optical interconnects, scanning and optical storage systems [1]. For applications in imaging and the implementation of parallel optical interconnects generally 2D arrays with a moderate number (< 100x100) of spots in each dimension are required. On the other hand for scanning as well as optical storage systems very large 1D spot arrays (> 1x200) are preferred. For Fourier-type array generators the complexity of the diffractive element strongly depends on the size of the array to be generated. The generation of large 1D spot arrays therefore requires the capability to fabricate very complex 1D phase functions. For this specific situation, the detour phase implementation yields an interesting possibility to make optimum use of the space bandwidth of the available lithographic process.

We implemented a 1x480 beam splitter grating for the application in optical storage systems as a kinoform detour-phase hologram (KDPH) [2][3]. The design and optimization of the phase profile necessary for this task was performed using an optimized iterative Fourier transform algorithm. In order to meet the requirements of high efficiency and low uniformity error it is necessary to provide high spatial resolution (i.e., a large number of pixels per period) as well as high phase resolution (large number of quantization levels). The design resulted in an element with 2048 pixels/period and 128 phase quantization levels. An implementation of such an element as conventional kinoform element is very challenging due to the necessary high phase resolution.

For our implementation we used a detour-phase implementation with an 8 phase level kinoform carrier grating oriented perpendicularly to the phase function. A carrier grating with a large period yields a large number of detour shifts per period (i.e., a high phase resolution in the Fourier plane). Due to the fact that the carrier grating is oriented perpendicularly to the phase function we were at the same time able to achieve the best possible spatial resolution for the implemented phase function. The large number of necessary detour phase levels did not affect the achievable spatial resolution. This specific configuration allows one to make use of the freedom in the second dimension which would not be exploited in a conventional kinoform element. By orienting a carrier grating with large periods perpendicularly to the phase function we are effectively trading high (detour-phase) resolution for the second dimension of the element. Fig.1 shows a grey scale picture of one period of the implemented diffractive element. Each grey level marks a dielectric phase level of the implemented kinoform carrier grating. The phase function is implemented through local detours of the carrier grating. The shape of the phase function can be observed in the figure. Fig. 2 shows CCD pictures of the diffraction plane of the element (measured uniformity error < 10% ; efficiency: 80%).

![Fig.1: Signal Plane](image1)

![Fig.2: Close-Up of the spot array](image2)