Sujet de stage M2

Original process development using interferential lithography

Context :

The subject is mainly oriented on technological development. Laser Interferential Lithography (LIL) is a micro-nanopatterning technique allowing to write periodic pattern in a photosensitive resist. The process is based on the phenomenon of constructive and destructive interferences created thanks to Lloyd mirror. The experimental set-up is represented on the figure 1.

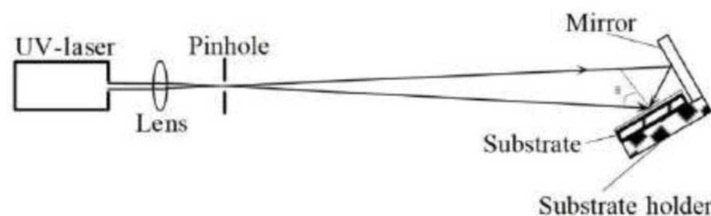

Figure 1 Experimental set-up of the Laser Interferential Lithography using Llyod mirror

The laser used is a UV laser emitting at 266nm at a power of up to 100 mW. The beam is directed and focused on a pinhole using a lens. The pinhole diverges the beam into "two" beams. One part goes on the sample to be structured, while the other is directed at a mirror that reflects the beam back onto the sample. Constructive and destructive interference between these intersecting beams creates patterns on the sample. These interferences creates a 1D grating whose period is equal to the distance between two interferences. This period can be adjusted by modifying the angle between the two beams, i.e. by rotating the platform with the mirror and the sample, and is determined by the following formula:

$T= \lambda / 2\sin\theta$

The patterns obtained are periodically organized in 1D or 2D as the example in figure 2.

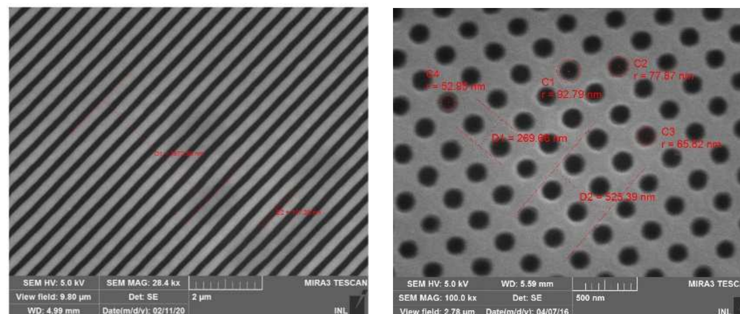

Figure 2 1D and 2D pattern obtained by LIL

The main limitation if this technique is the limited access to periodic structures.

To bypass this limitation, we propose to develop the Talbot process on our experimental set-up. The Talbot effect is an optical diffraction phenomenon that occurs when monochromatic

light passes through a periodic diffraction grating (mask) and forms a regular diffraction pattern (image) repeated at a regular distance from this grating. The regular distance is called the Talbot length zT, and the repeated images are called Talbot images.

In our case, the idea is to place a grating in front of the spatial pattern filter with a hole diameter smaller than the laser wavelength (266nm), so that the beam diffracts and forms interference on the substrate. By moving the sample one Talbot length during exposure, we can obtain the sum of all the images and sub-images making up the Talbot image as illustrated on figure 3.

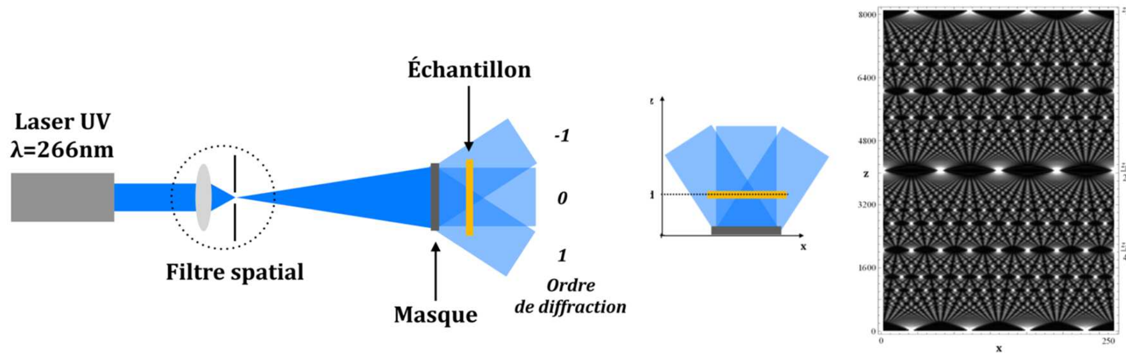

Figure 3 On the left : Litho Talbot assembly – On the right : Talbot image repeated at periodic intervals zT in the direction of light propagation

To carry out this project, after training, the student will have to master LIL lithography and then set up the experiment to be able to expose the resin through different masks.

Depending on the student's affinity for simulation, experimental results can be compared with simulation results for dose distribution in the exposed resin.

The student will be expected to familiarize him/herself with the tools available on the NanoLyon platform, in a cleanroom environment. The student will need to be autonomous, and as the tools at his/her disposal are highly sensitive, he/she will need to be extremely rigorous. A first experience in technology is expected. The student develop an expertise on clean room technological process.

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