LASER PHOTOPLOTTER FOR MASK AND DIRECT PHASE WRITTING

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We present a self-made laser photoplotter developed to serve the scientific and technical community in the task of high-resolution mask manufacturing and direct writing of diffractive continuous phase objects. In its current configuration (Figure 1), the laser photoplotter has demonstrated the next capabilities with binary masks:

Mask size: up to 250x 200 mm
Critical dimension: down to 1.5 μm,
Absolute accuracy: 0.6 μm.
Writing strategy: vector-scan

The equipment has been designed in a very flexible way: both vector-scan and raster-scan strategies will be available for binary masks, whereas raster-scan will be used for direct phase writing. The motivation which leads us to undertake this project is the necessity for flexible and in-the-house manufacturing of diffractive optics, micro optics, phase and amplitude diffraction gratings, masks for lithography and reticules. The main application of this technology (in reference with the research line of the promoting research group), is the continuous improvement of optical encoder and sensor technologies, as well as miniaturization of the same. Besides this, the results of the project present worldwide application capabilities. This is because diffractive optics, micro optics, diffraction gratings and high precision and resolution masks and reticules are key elements in many enabling technologies and industrial processes (for example MEM's and MOEM's, photonic devices, etc..).

The relevance of the results of this projects are even greater, if we take into account that there is no other installation in Spain for diffractive optics, micro optics and mask manufacturing with the intended capabilities of size (300×500 mm), critical dimension (0.5 μm) and accuracy (±1 micra/500 mm).

The laser, contrary to standard systems, is a NGa semiconductor laser from Nichia, with a wavelength of 405 nm and cc power of 30 mW. The laser driver allows for digital (10 MHz TTL) and analog (500 KHz @3dB) modulation. This characteristic largely simplifies the optical set up, as AO modulators are no longer needed. The laser is delivered to the writing head through a polarization preserving, monomode fiber. This feature adds extra flexibility in the system design and provides with a high quality beam ($M^2 = 1.05$) Although in its current status low NA objectives have been employed, high quality beam will be necessary to reach the smallest focusing spot, about 0.5 μm. By means of a Kineflex coupling system from Point Source, an injection efficiency of about 74% has been achieved, with very good long term stability (10 hour RMS fluctuations better than 1 %) .

We have also design a novel autofocusing scheme, in which the writing beam is also used for autofocusing purposes without appreciable losses. The autofocusing system is based on the beam polarization to get much of the incident light out of the main optical path. For binary mask writing, the laser is modulated from 100% to 10% of the total available irradiance, which is a range large enough for a proper irradiation of the photoresine.

Currently, we are implementing the software for raster-scan strategy based on PEG (position event generator). Also, we are making the first trials to calibrate the system and adjust the parameters for direct phase writing.

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Figures:

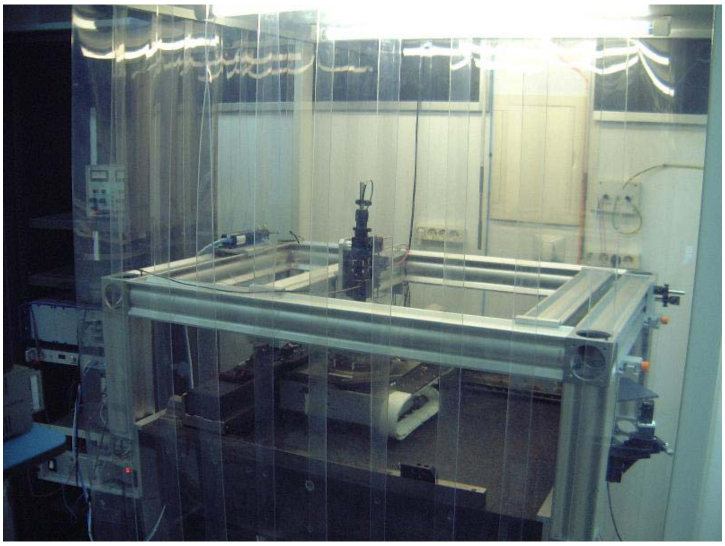

Figure 1. General view of the laser photoplotter.