MULTI-FOCAL MULTI-PHOTON MICROSCOPY FOR FAST PARALLEL DIRECT LASER WRITING

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Multi-photon optical microscopy is the basic instrument for laser direct writing and has played an important role in micro/nano-fabrication of next generation optical devices, in particular for the three-dimensional micro/nanophotonic structures such as multi-dimensional optical data storage devices [1] and three-dimensional photonic crystals [2-4]. However, due to the beam focusing nature of this technique, the speed of fabrication is limited by the scanning stage or other light steering devices. Another limitation is the poor repeatability from site to site. A way to overcome this hurdle is to adopt a multi-focal multi-photon optical microscope. In this paper, we demonstrate a holographic multi-focal multi-photon optical microscopy system which is capable of producing parallel, arbitrary, and variable patterns. This system is achieved by using a spatial light modulator (SLM) displaying a computer generated hologram (CGH), as shown in Fig. 1. The beam from a femtosecond laser is expended and illuminates on a SLM. Through a 4f imaging system, the phase pattern from the SLM is transferred to the back focal plane of a high numerical aperture objective. Finally, the desired pattern at the front focal plane of the objective is achieved by the Fourier transform (FT) of the phase pattern. The proposed method can be applicable to the direct laser fabrication of any 3D arbitrary structure by layer-by-layer exposures with a speed two orders of magnitude faster than the traditional method.

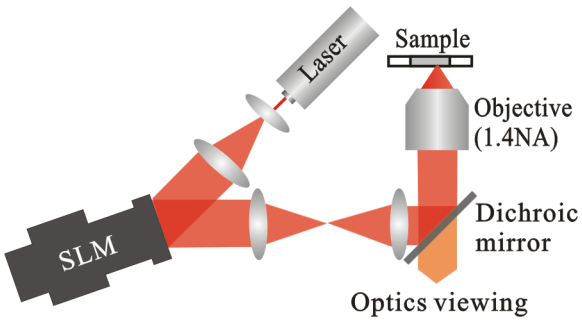

Figure 1 Schematic of the SLM-based multi-focal multi-photon microscopy system

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