ON-CHIP LIGHT SHEET MICROSCOPY FOR NANOPARTICLE
CHARACTERIZATION AND CELL IMAGING

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Abstract

Light Sheet Microscopy uses a thin sheet of light to illuminate a particular plane in the sample orthogonal to the detection pathway. Since the light sheet coincides with the focal plane of the detection objective lens, only objects within the focal plane are illuminated, while regions outside the focal plane remain dark. Thus, the technique is a unique combination of speed and high contrast with reduced photodamage of the samples, a trait particularly useful during prolonged imaging of living organism. Traditionally, Light Sheet microscopes make use of two objective lenses, the one placed orthogonally respect to the other. Spatial constraints make this approach difficult in combination with often bulky high numerical aperture objective lenses.

Here we make use of a disposable microfluidic chamber with built-in micromirror to enable single-lens high resolution SPIM, as illustrated in Fig. 1. Two different designs were fabricated and evaluated, one based on a silicon substrate, the other on a polished polymer sheet. An accurate characterization of the on-chip light sheet shows a light sheet thickness of 3 µm at 647 nm. The contrast that is obtained using the disposable microfluidic chips is of equal or better quality in comparison with a commercial swept field confocal microscope using the same objective lens.

Figure 1  Illustration of microfluidic chip with integrated tilted micromirror.

A pre-shaped elliptical Gaussian beam is directed through the objective lens onto the optically flat tilted micromirror so as to create a light sheet inside the channel that coincides with the focal plane of the objective lens. Thus, the same objective lens is used both for illumination and detection. As these microfluidic chips can be mass-produced using standard lithographic techniques, it is expected that they may open up the possibility of performing LSM on standard microscope bodies.