LIGHT SHEET MICROSCOPE WITH AN OPTOFLUIDIC CHIP: APPLICATIONS IN SINGLE CELLS AND DROSOPHILA IMAGING

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Opto-fluidic technologies integrate multiple fluidics and photonics devices in a miniaturized chip. Among many lab-on-chip applications, they can be used for optical microscopy [1]. We have previously reported a millimeter-scaled optofluidic device that incorporates light-sheet illumination and automatic sample delivery and scanning. This device upgrades a standard inverted microscope to a high throughput LSFM system [2].

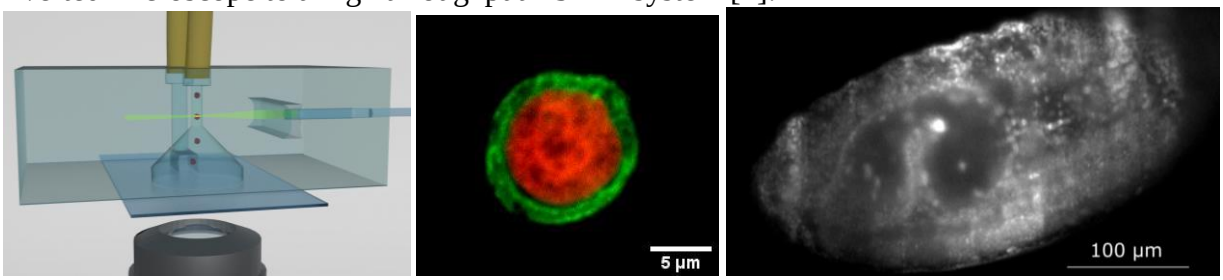

Figure 1: Rendering of the chip.(left). Section of a cancer cell labelled with mCherry in the nucleus and Alexa 488 in the membrane (center). Section of a Drosophila embryo expressing GFP (right).

Here we present two opto-fluidic devices that allow automatic scanning and imaging of single cells and of entire Drosophila embryos. A cylindrical lens fabricated by Femtosecond Laser Irradiation followed by Chemical Etching (FLICE) is integrated with an optical waveguide or an optical fiber on a fused silica chip. The lens is used to illuminate a single plane of the sample, at two alternating wavelengths. The samples flow in a three-dimensional fluidic network (fabricated by FLICE too) and is then imaged on a CMOS camera at 200kHz. We show the design and optimization of the lab on chip, together with the technological solutions for automatic sample alignment (in particular of the Drosophila embryos along their axis) and for high NA (1.1) imaging of cancer cells. The devices allow performing dual-color, three-dimensional, automatic imaging of several samples per minute.

[1] Paiè, P., Martínez Vázquez, R., Osellame, R., Bragheri, F., and Bassi, A. “Microfluidic based optical microscopes on Chip” Cytometry Part A, 93, 987-996 (2018).
[2] Paiè, P., Bragheri, F., Bassi, A., and Osellame, R. “Selective plane illumination microscopy on a chip” Lab on a chip, 16(9), 1556-1560 (2016).