Bio Ocean Nano

Pressure Driven HepG2 Cells Focused on a Microchip

P-E POLENI, O. DUCLOUX, S. OSTROVIDOV, H. FUJITA, T. FUJII

LIMMS / CNRS UMI 2820 & Institute of Industrial Science, The University of Tokyo, Japan

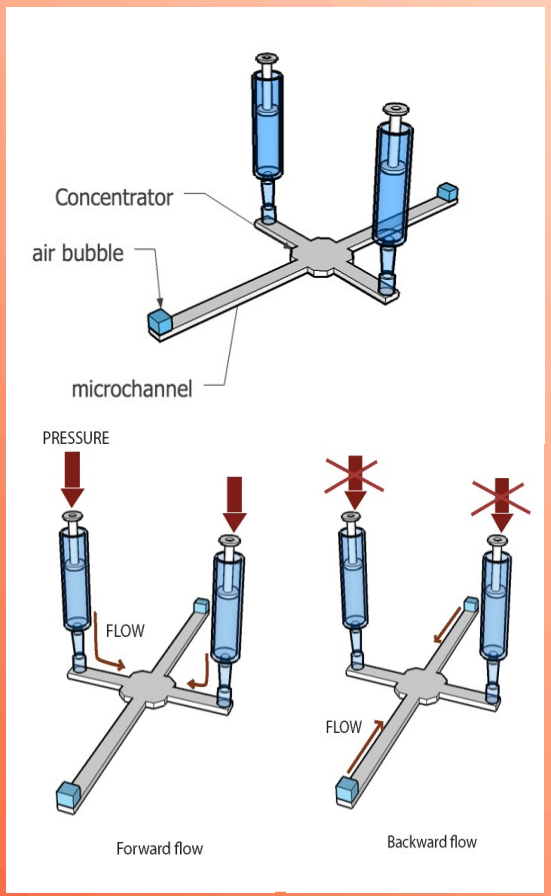
Contact: poleni2003@yahoo.fr

1. Abstract

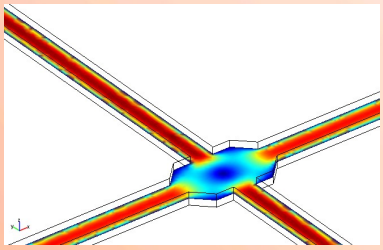
We propose an original solution to easily perform cell concentration in a confined environment. It consists in two perpendicular microchannels and a chamber situated at the intersection. At both ends of the microchannel 1, an arbitrary pressure P1 can be applied. P1 is identical on both ends. The ends of the microchannel 2 are filled with rigid caps which have an identical volume of air. When P1 is applied, the pressure increases and the air volumes in the caps are compressed. A flow is generated in channel 2 from the chamber to the air-caps. As the pressure applied on the ends of microchannel 1 decreases, the volume of air inside the rigid caps inflates, generating a flow in channel 2 from the air-caps to the chamber. An actuation cycle corresponds to a compression step followed by a decompression step at the ends of channel 1. The culture medium-contained human hepatocarcinoma (HepG2) cells is flown back and forth into the chamber by pressurization /de-pressurization cycles of two rigid caps which contain the same volume of air. This phenomenon leads to the appearance of a dead volume in the center of the chamber in which HepG2 cells can be concentrated and aggregated in 3D. Particle Tracking Velocimetry (PTV) and simulation (FEMLAB) studies of the flow suggest that the symmetry of the flow induces the presence of a dead volume in the culture microchamber, favouring a fast cell trapping of HepG2 cells which aggregate rapidly in the microchamber.

2. Experimental System & Performances of the Actuation

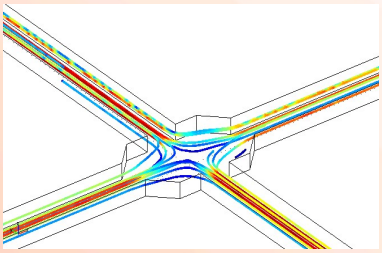
Principle of Actuation



Simulated Velocity Field (m/s)



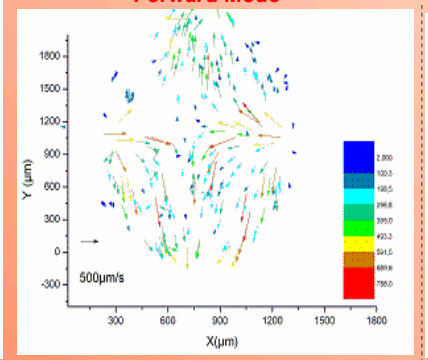
Simulated Flow Field (m/s)



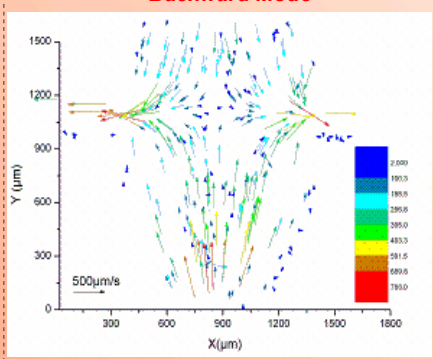
Velocity & Flow Field Simulations (FEM Solver) clearly demonstrate a dead volume at the center of the chamber devoted to cell culture

Pressure-Driven HepG2 cells' Concentration & Aggregation in the Center of the Microchamber

Forward Mode

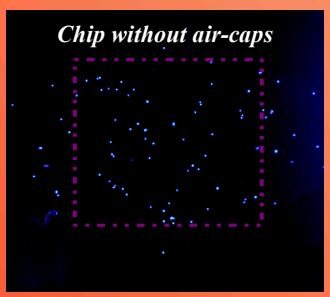


Backward Mode



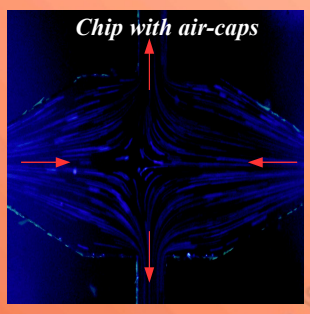
Nuclei Staining Hoechst33342

Chip without air-caps



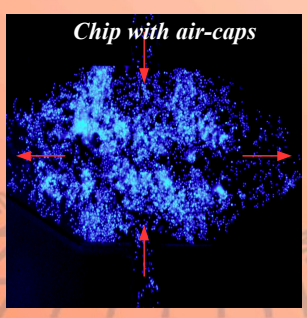
Nuclei Staining Hoechst33342

Chip with air-caps



Nuclei Staining Hoechst33342

Chip with air-caps



PTV experiments, using HepG2 cells' nuclei as representative of 2µm fluorescent polystyrene beads, support the presence of a dead volume, foavouring cell trapping, concentration & aggregation of hepatocarcinoma cells at the center of the chamber devoted to cell culture.

6. Conclusion

Our microfluidic device, which contain air-caps, enables 3D culture of Hep G2 cells in high density (50-fold higher as compared to the case with the absence of air caps) in very confined microenvironment (V ~ 0.3 mm^3). We are therefore confident that the present system will have a significant impact on the development of new generation of platforms for tissue engineering, drug delivery or testing & other cell-based assays, especially by integrating and automatic injections technologies (electrosomotic pumps).