Biochemical Nanofactory

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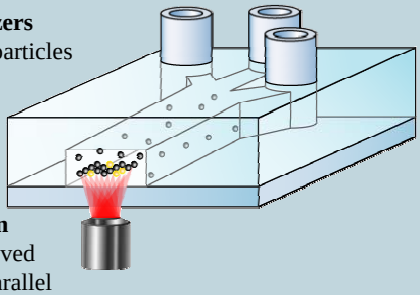
Objectives

Downscale chemical's consumption and biotechnological production & analysis to the ultimate limits through:

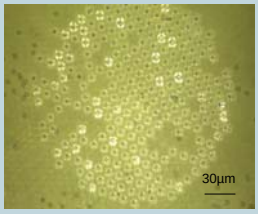
- **Multiple optical tweezers** for capturing arrays of particles
- **Micro-fluidics** for addressing particles with reagents
- **Fluorescence detection** for analyzing time-resolved chemical reactions in parallel



Multiple optical trapping

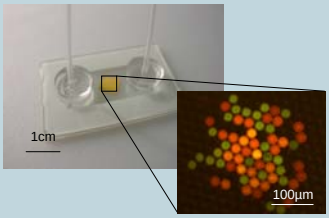
Microscope system

- 200 traps
- Adapted for working on biologist's microscopes
- System based on off-chip microlens arrays



On-chip system

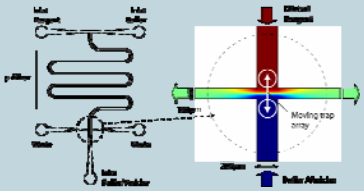
- Adapted integrated optical traps based on high-NA parabolic micromirrors
- Currently 100 traps, but system is scalable
- Micromirrors simultaneously serve as fluorecence collectors



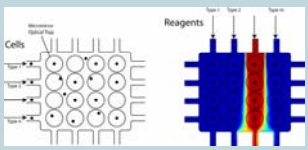
Micro-fluidics

Simulations in prototype microfluidic devices

Reagent mixer & gradient generator



Cross-flow reactor



Practical realizations at CSEM

Top and bottom glass chips with an intermediate biocompatible laser-cut tape layer containing the micro-fluidic channels

Conclusions

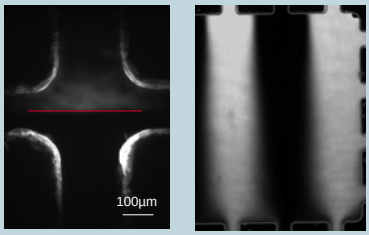
- Demonstration of large arrays of optical traps adapted for working within microfluidics (microscope & on-chip systems)
- Laser-cut tape micro-fluidic prototypes produced expected diffusion properties, and showed good compatibility with laser multiple trapping.
- Fluorescence imaging on arrays of trapped biological particles in microfluidics demonstrated

Bio-chemistry

Testing microfluidic circuits

Testing laminar flows and diffusion dynamics in microfluidic circuits with a fluorescein dye.

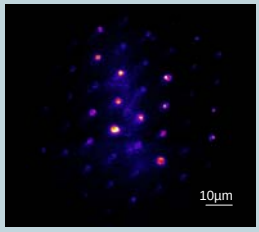
The experiments confirm the dynamics expected from the simulations



Fluorescence detection on multiple native vesicles trapped in microfluidics

Fluorescence microscopy was employed to observe ligand binding on multiple optically trapped native vesicles.

Native vesicles were produced from HEK 293 cells expressing the NK1R receptor. The agonist substance P was fluorescently labeled with rhodamine.



Collaborations

- TECAN AG (Prof. P. Ryser)
- FISBA OPTICS, (Dr. M. Forrer)
- WEIDMANN PLASTICS TECHNOLOGIES (M. Lüthy)
- GIVAUDAN AG (Dr. B. Schilling)

Publications

- F. Merenda et al : Miniaturized high-NA focusing-mirror multiple optical tweezers. Opt. Express 15(10): 6075-6086 (2007)
- F. Merenda et al: Refractive multiple optical tweezers for parallel biochemical analysis in micro-fluidics. Complex Light and Optical Forces, San José, Proc. SPIE. 6483-08 (2007)
- G. Gopalakrishnan et al: Multifunctional lipid/quantum-dot hybrid nanocontainers for controlled targeting live cells. Angew. Chem. Int. Ed., 45, 5478-5483 (2006).