Microfluidic chips with nanostructures for investigation of biological objects by methods of high resolution microscopy

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Microfluidic devices are used in preparation and analysis of liquid samples in chemistry, biology, pharmacy and medicine. One of the promising directions is a creation of microfluidic chips (MFC) with integrated nanoscale structures. Nanostructures in MFC allow to create modern analytical devices with unique characteristics. Combining these MFC with the instruments and methods of high-resolution microscopy enables to receive new analytical system for studies of biological objects in its natural (native) state.

In present work we have designed and fabricated a MFC with integrated net of nanochannels for fixation of biological samples in their native environment during study by scanning probe microscopy and confocal laser scanning microscopy. We used microchip topologies with hydrodynamic traps from nanoscale channels which link microchannels. These topologies were created by method of focused ion beam lithography. The width of fabricated nanochannels is in the range from 50 to 300 nm. This parameter depend on the size of investigated biological objects. Fabricated MFC were investigated on test samples (fluorescently labeled polymer beads) in liquid buffer solution.

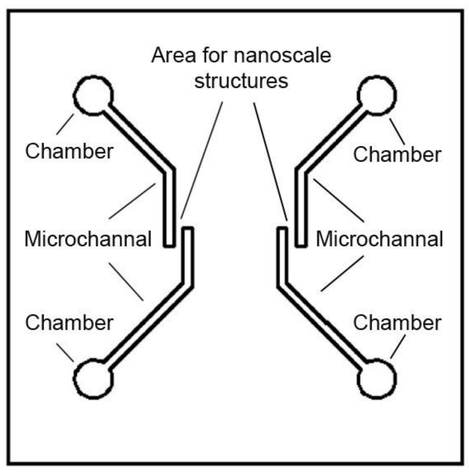


Fig.1. Design of the initial chip with microchannels.

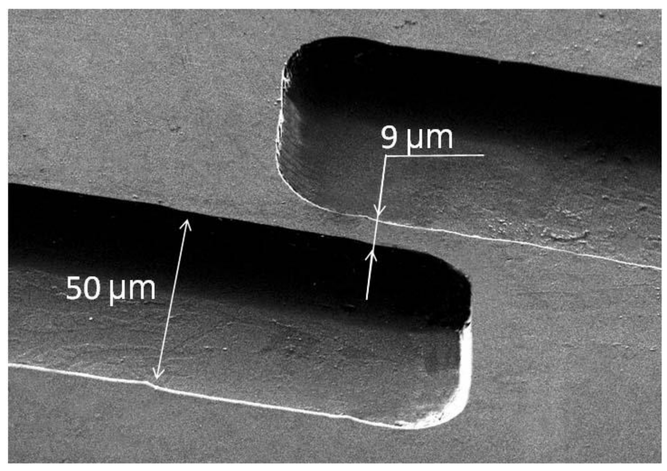


Fig.2. SEM image of microchannels on the initial chip.

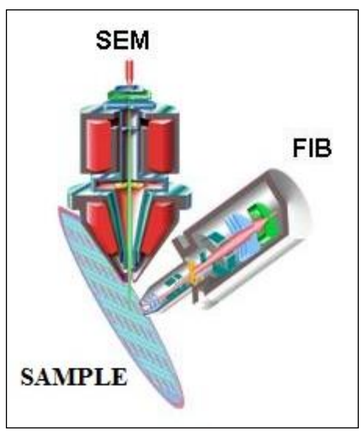


Fig.4. Equipment for nanoscale structures fabrication on chip (Carl Zeiss CrossBeam Neon 40).

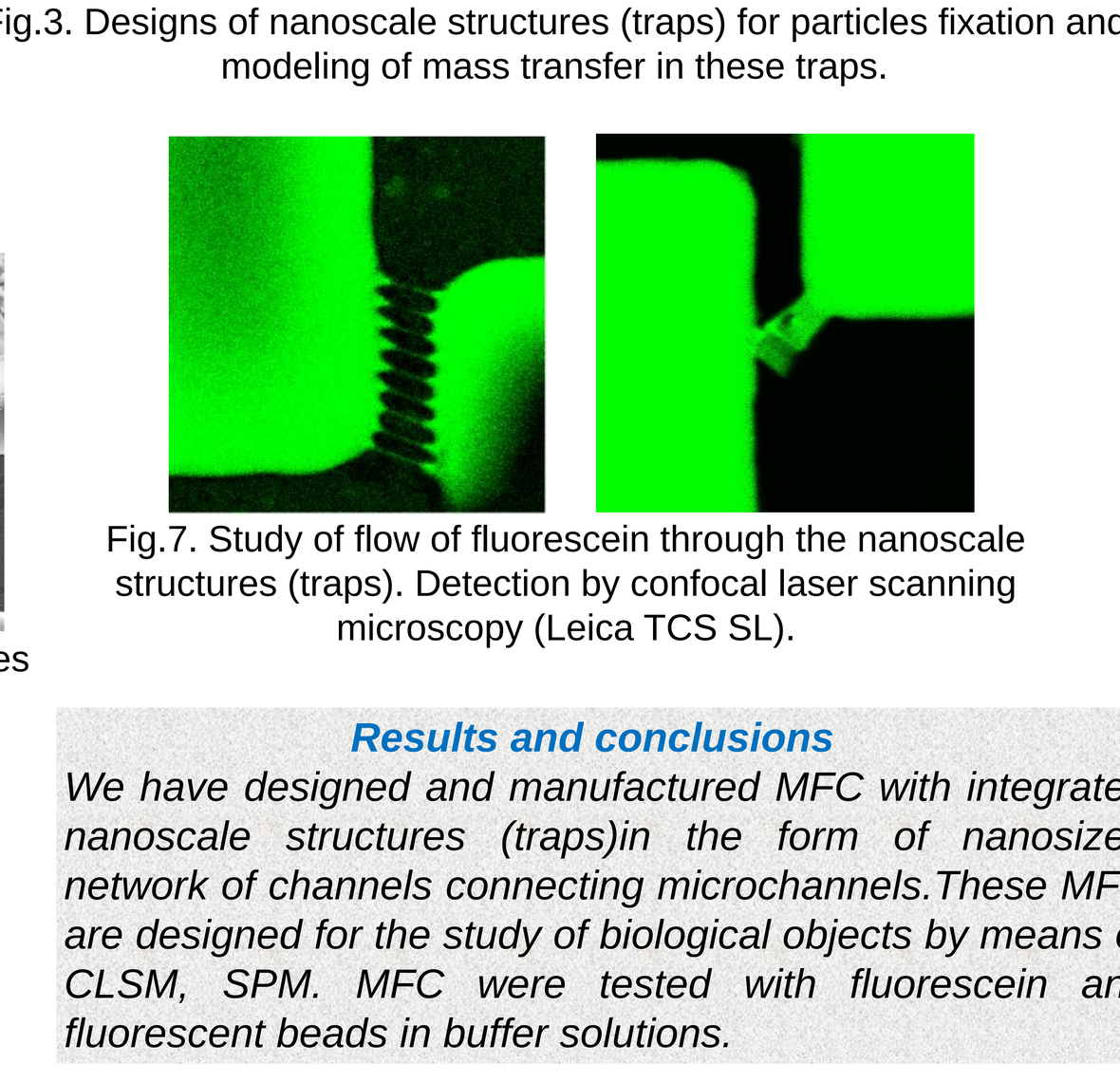


Fig.3. Designs of nanoscale structures (traps) for particles fixation and modeling of mass transfer in these traps.

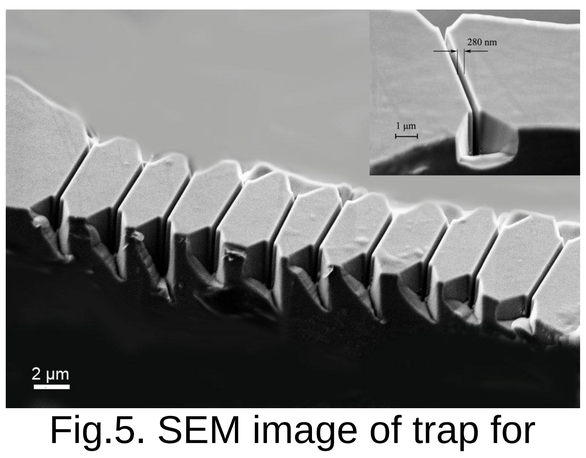


Fig.5. SEM image of trap for particles with nanochannels net.

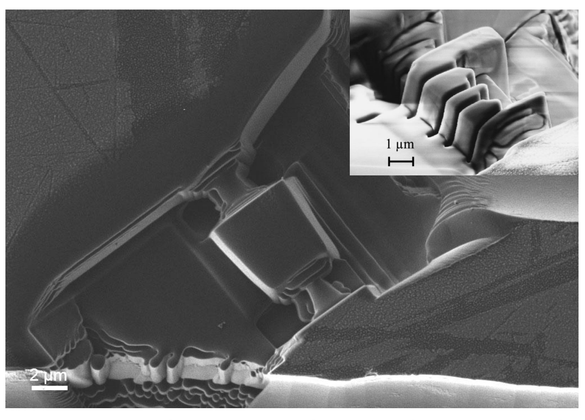
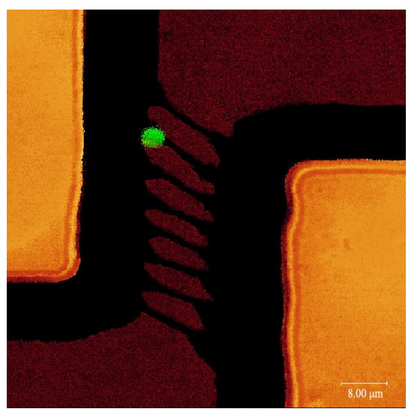


Fig.6. SEM image of trap for particles with special cell.

Fig.7. Study of flow of fluorescein through the nanoscale structures (traps). Detection by confocal laser scanning microscopy (Leica TCS SL).



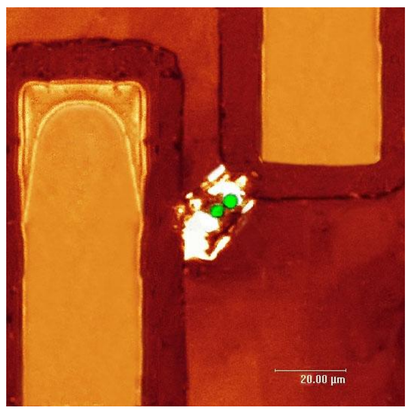


Fig.8. Results of experiments on fixation on nanoscale structures (traps) of fluorescent beads. Detection by confocal laser scanning microscopy (Leica TCS SL). Microparticles based on melamine resin, FITC-marked with diameter 3 µm in the buffer solution (green marks in the pictures).

Results and conclusions

We have designed and manufactured MFC with integrated nanoscale structures (traps)in the form of nanosized network of channels connecting microchannels.These MFC are designed for the study of biological objects by means of CLSM, SPM. MFC were tested with fluorescein and fluorescent beads in buffer solutions.

Acknowledgment

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