FIB Deposition of Platinum Micropillars in Microchannels for Diffusion Control in Microfluidic devices

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Focused Ion Beam Induced Deposition (FIBID) using organometallic precursors is frequently employed for deposition of many kinds of materials, like metals and insulators[1]. In this work was used Pt deposition to create micropillars in channels for microfluidic devices. The main application of this deposit is to increase the Reynolds numbers of lowing liquids to improve the control of mass diffusivity to enhance the mixture of different fluids.

The microchannels were fabricated on silicon substrates, glass and polydimethylsiloxane (PDMS), sealed with PDMS. The main goal of this research is to manufacture prototype microfluidic devices using the routines of conventional microfabrication, involving cleaning, lithography, wet etching and sealing. These prototypes are applied to study hydrodynamic interactions in mixtures. The fluidic microsystem uses liquid injection by a syringe pump and inspection is done by an optical microscope with a digital camera. The results of tests were compared with simulated hydrodynamic computer models. With the aid of modeling multiphysics simulation Comsol software (Fig. 1) and practical tests with laboratory devices it was possible to obtain prototypes operating in typically laminar flow conditions, with Reynolds number from 0.79 to 8.70; with the following dimensions of the microchannels: width from 100 to 458 µm, depth from 20 to 64 µm, and with different channel profiles: trapezoidal for silicon, circular segment for glass and rectangular for SU-08 / PDMS. Comparison between simulation and experiment was done for the case without the pillars, with satisfactory results. Simulation results (Fig. 1) also show strong increase of mixture of liquids in channels in the presence of pillars. Comparison between simulation and experiment in the case of pillars (height from 10 to 30 µm, lateral dimensions from 20 to 30 µm) inside the channels, fabricated by FIB (Fig. 2) are under way.

References:

[1] P. Russell, I. Utke, and S. A. Moshkalev, Nanofabrication Using Focused Ion and Electron Beams: Principles and Applications.

[2]Madou, M. J. Fundamentals of Microfabrication: The Science of Miniaturization. CRC Press. Washington, USA. 2ed. 2002.

[3] Whitesides, G. M. The origins and future of microfluidic. Nature. Vol. 447. n. 27. 368 – 373, 2006.

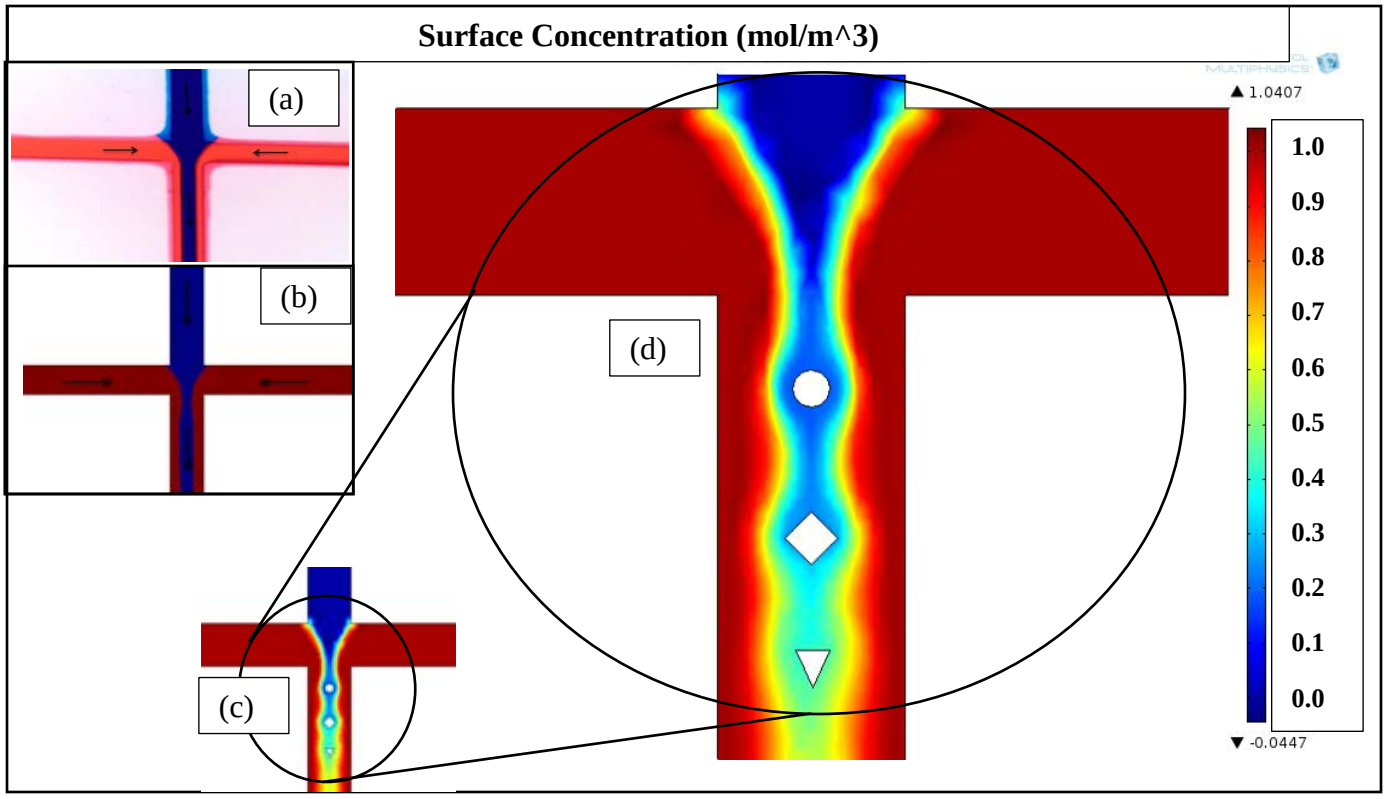

Figure 1: Comparison between simulation and experiment without pillars. (a) Experiment without pillars, (b) Simulation without pillars. (c) and (d) Simulations of pillars inside of microchannel, device like micromixer, increasing the mass diffusivity.

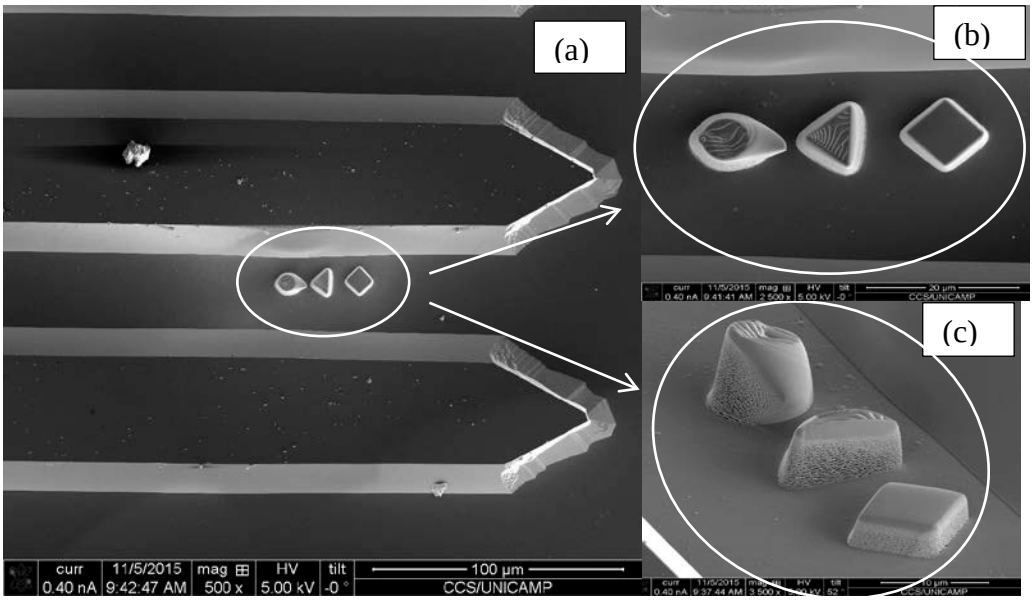

*Figure*2: High-resolution MeV imaging reveals that the FIBD deposited Pt pillars are in center of microchannel (a). (b) and (c) show that the pillars shapes.