Fluidic particle transport at interfaces through actuated micro-hairs with switchable nano structure

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Microfluidic is the field of microsystem technology which handles small volumes of fluids. There are a couple of methods to transport and separate particles in closed channels, like electrophoresis, electromagnetism, physicochemical transport, and peristalsis. However some problems require particle transport in open channels (absence of second wall or large distance between the walls). Common issues are anti-fouling surfaces, micro processing of open systems, or the prevention of concretion at implants. In these cases the traditional microfluidic transport mechanisms are not applicable due to the absence of second boarder.

This research project focuses on the development of micro structured foils with arrays of microscopic flaps (see figure 1). The top of each flap is covered with Carbon-Nano-Tubes (CNTs) and polymeric brushes. Each single flap is separately moved by an induced pneumatic force, which bends the surface covering membrane. This membrane movement is converted in a small z-axis movement of the flap and a much bigger angle rotation. Due to the high scale factor between height and thickness of the flap the angle rotation results in a fluid movement parallel to the surface. A movement of the fluid, which transports particles, reduces the particle deposition.

To dispose the needed pneumatic pressure at the right position and time, it is important to achieve perfectly timed actuation points for the valves, which are sued for the pneumatic actuation. A switched open valve results in an increasing pressure at the membrane. The gradient of the membrane pressure depends on the pressure level at the main pipe, which delivers the working-pressure. A high pressure level above ambient leads to a fast growing membrane pressure, whereas a low pressure level results in a slow growing membrane pressure. Before the membrane pressure reaches the working-pressure the valves are switched again. That implies that the desired membrane pressure is specified by a correct valve-actuation time.

The membrane and the moving flaps are fabricated in silicone using soft-lithography technologies.

The pneumatic particle transport is enabled by modification of the flap tips. Each particle is handed from one flap to the next by switching the adhesion properties of the polymer brushes on top of the flaps. The traveling wave of the silicone flap and the matching switch between the two adhesion properties of the brushes are able to prevent the suspended particles from deposition on the surface.

In this way the threefold of structured foil with a bunch of flaps and the nanostructure CNTs with the switchable polymer brushes is able to achieve an unprecedented level of functionality.

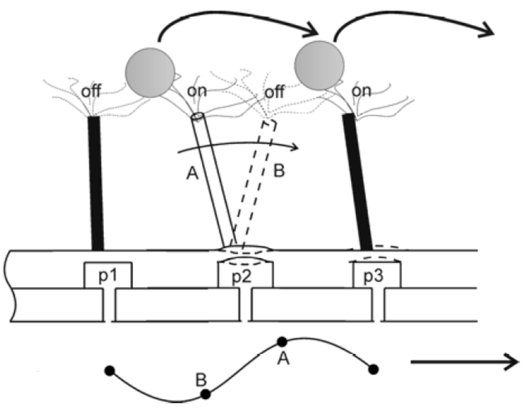

Fig. 1: Sketch of particle movement

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