Slippage on hierarchical superhydrophobic surfaces (theory, simulation)

The exceptional wetting properties of superhydrophobic (SH) surfaces [1] have motivated numerous applications in microfluidics. In particular, patterned SH surfaces were shown to exhibit low friction (superlubricating) properties in the Cassie state, i.e. when the liquid interface lies at the top of the roughness and thus reduces the solid-liquid contact area [2,3].

The hierarchical fractal nature of SH surface was shown to enhance the robustness of the Cassie state with respect to the Wenzel state (with the liquid impregnating the roughness), as compared to simple regular structure [4]. Recent experiments have shown that a hierarchical surface with nanoposts lying on the top of microposts does not necessarily lead to an increase in the effective slip length [5].

This research project involves theoretical analysis and Lattice Boltzmann simulations of a liquid flow past a fractal SH plane with both isotropic and anisotropic pattern. These simulations will be performed in collaboration with the group of J. Harting at TU Eindhoven, The Netherlands [6]. The main goal is to determine, how the effective slip length depends on the number of hierarchy levels. This research would provide guidelines for an intelligent design of extremely water-repellent materials for various lab-on-a-chip applications.

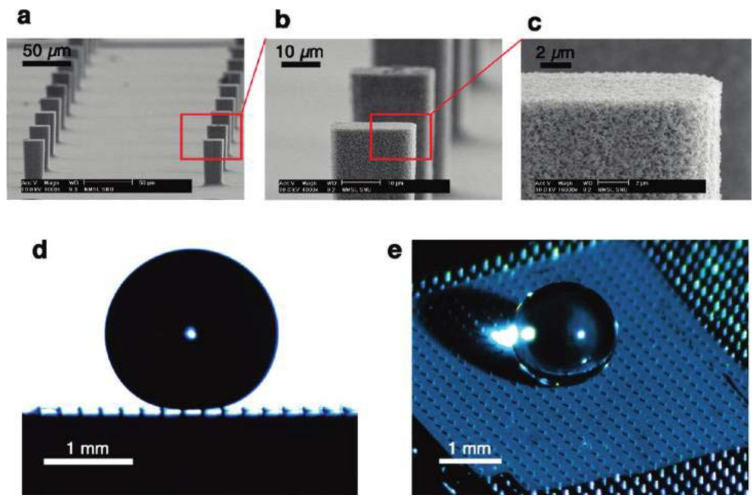

Fig. 1. Droplet on the fabricated nano-micro-roughened hierarchical surface (from [3]).

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