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Superhydrophobic Manipulation of DNA

Marini M[1], **Limongi T**[1*], **Allione M**[1], **Falqui A**[2] **and Di Fabrizio E**[1]

[1]*SMILEs lab, PSE and BESE Divisions, King Abdullah University of Science and Technology, Thuwal, 23955-6900, Kingdom of Saudi Arabia*

[2]*NABLA lab, BESE Division, King Abdullah University of Science and Technology, Thuwal, 23955-6900, Kingdom of Saudi Arabia*

[*]**Corresponding author:** Tania Limongi, SMILEs lab, PSE and BESE Divisions, King Abdullah University of Science and Technology, Thuwal, 23955-6900, Kingdom of Saudi Arabia, Tel: 009660128082303; E-mail: tania.limongi@kaust.edu.sa

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Introduction

Superhydrophobicity refers to surfaces on which drops assume a quasi-spherical shape and a high contact angle (more than 150°). This well-known phenomenon occurs in nature and we can take advantage of this principle fabricating bio-inspired superhydrophobic surfaces constituted of ordinate arrays of silicon micro-pillars. As previously reported, these devices can be used to concentrate and detect highly diluted molecules (down to the attomolar concentration, [1]) or to obtain micrometric suspended nucleic acids bundles [1-4] for their direct imaging. To reach this purpose, a droplet of solution containing the molecule of interest is deposited on the micro-pillars array and let evaporate until dry. In the images here reported, we show the final result of the evaporation of a 5 µl droplet of a saline solution containing double strand DNA on a periodical circular lattice of micropillars (6 µm in diameter and 12 µm interdistance). Under controlled temperature and humidity condition, we obtained bundles of genomic (Figure 1 panel A) and lambda DNA (Figure 1 panel B), both diluted (approximately 60 pM concentration) in saline buffer solutions containing mono- or bi- valent cations at a physiologically compatible pH. The DNA obtained bundles are linked from one pillar to another following the direction of droplet evaporation. Their observation does not need any additional preparation or treatments that could affect the native structure of the double helix. The images were taken using a field emission scanning electron microscope (FEI, Quanta 200), working at an acceleration of voltage of 5 kV and using the secondary electrons signal. The results achieved can have several applications and extended to a wide range of molecules. For example, the suspended material can be deeply investigated by spectroscopy techniques such as Surface Enhanced Raman Spectroscopy (SERS)/ Raman without much restrictions on the molecular concentration in solution. Another option is the insertion of a regular array of holes between micro pillars. This allows to image suspended macromolecules with a high-resolution transmission electron microscope (HRTEM). Recently, we coupled superhydrophobic surfaces and TEM to obtain a direct image of a suspended single DNA molecule, revealing its inner structure [7] as well as its major features [5-7]. The direct imaging and the spectroscopic characterization of suspended biomolecules can open the way to understand molecular aspects and structural properties of molecules, as well as their interaction and dynamics, such as the ones occurring between proteins and nucleic acids.

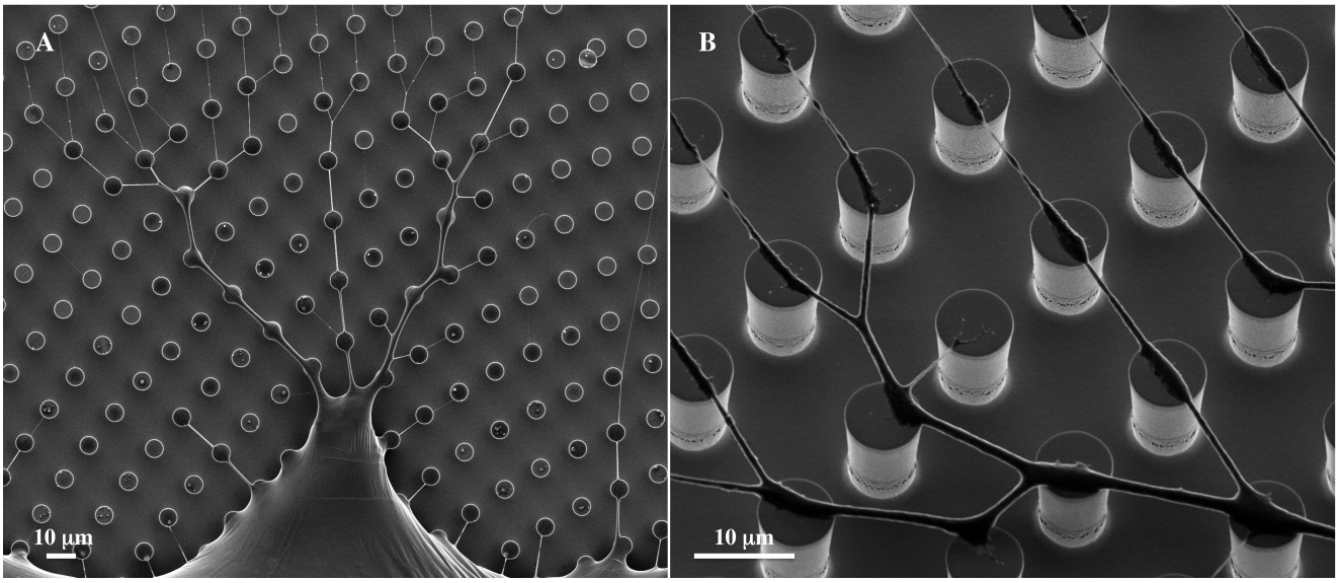

Figure 1: Superhydrophobic Manipulation of DNA.

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