BIO-NANOTECHNOLOGY: TEMPLATED ASSEMBLY OF FUNCTIONAL NANOSCOPIC ELEMENTS ON SURFACES

Dimitrios Stamou, Pierre-Yves Bolinger, Claus Duschl
LCPPM, Institut de Science Biomoleculaire, Ecole Polytechnique Federale de Lausanne, CH-1015, Lausanne, Switzerland
E. Delamarche
IBM Research, Zurich Research Laboratory, CH–8803 Ruschlikon, Switzerland
E-mail: dimitrios.stamou@epfl.ch

Self-assembly of supramolecular buildings blocks (e.g. vesicles, carbon nanotubes, nanoparticles) is an emerging approach to the fabrication of functional nano-sized architectures of far greater complexity than the one attainable by "conventional" microstructuring. Two examples of confined-volume systems are presented.
First we describe a method that allows the massively parallel isolation of attoliter experimental volumes and their self-assembled positioning with 100-nm precision in ordered arrays on surfaces.[1] Using lipid-bilayer vesicles as molecular-shuttles we transported and localised molecules encapsulated in their aqueous interior or embedded in the lipid matrix. The site-selective immobilisation of intact single vesicles (SVs) was mediated by patterns of receptor molecules defined by microcontact printing (μCP) on glass, see Figure 1. One-step directed self-assembly (SA) produced mixed arrays of ~10^6 SVs per mm^2 within minutes while consuming a total reagent volume of a few picoliters. A natural extension of this work is the arraying of vesicles produced directly from cells. Native vesicles can carry receptor proteins expressed in cell membranes and/or signal transduction machinery from the cytosol, they may thus be used to screen binding and activity of therapeutical compounds (drug candidates) or an induced functional response.
In a further step we developed a system that allows the on-demand release and mixing of water-soluble compounds in the interior of vesicular nano-containers.[2] The reactor device comprises a nested system of lipid vesicles part of which release their cargo in the interior of the others during a thermotropic phase transition, see Figure 2. The performance of individual reactors immobilized on glass is characterized using confocal microscopy and a fluorescent dye that reports dilution during the release. The results confirm the predicted temperature induced response and reveal a release with a transition width of 3 ºC and a half time of ~ 1 min. Such a reactor system is entirely autonomous as it does not rely on external input of compounds but integrates rather in a single element all reactants and products, hence its overall dimensions can be effectively reduced to the nanometer range. (submitted)

References:

1. Stamou, D., Duschl, C., Delamarche, E. & Vogel, H. Self-Assembled Microarrays of Attoliter Molecular Vessels. *Cover page article, Angewandte Chemie Int. Ed.* **42**, 5580-5583 (2003).

2. Bolinger, P. Y., Stamou, D. & Vogel, H. Integrated nano-reactor systems: Triggering the release and mixing of compounds inside single vesicles. *submitted*.

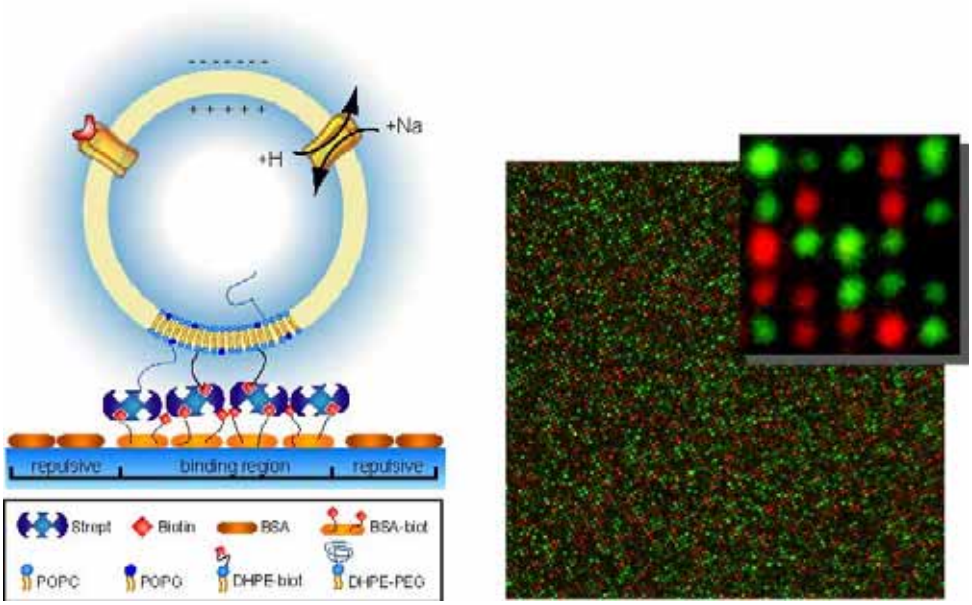

Figure 1

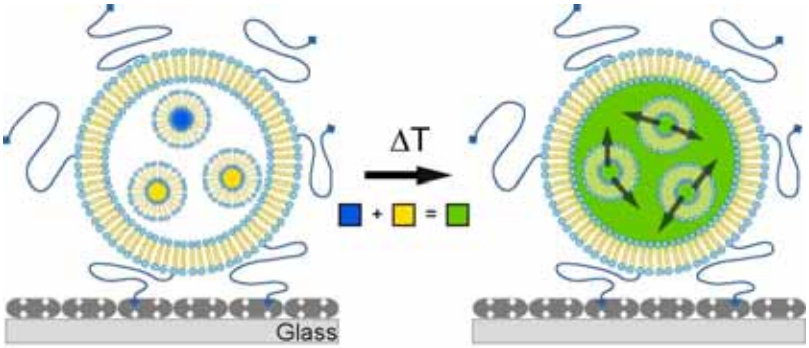

Figure 2