Self-assembly of DNA origamis for nanolithographic applications

Nicolas Triomphe[1,2], Ludwig Rotsen[1,2], Guido Rademaker[2], Raluca Tiron[2], Gaëtan Bellot[1,*]
[1]Université de Montpellier, INSERM, CNRS, Centre de Biologie Structurale, 34090, Montpellier, France
[2]Université Grenoble Alpes, CEA, LETI, F-38000, GRENOBLE, France
[*]gaetan.bellot@cbs.cnrs.fr

Keywords: DNA origami, microelectronics, lithography, self-assembly.

In nanotechnology in general and in semiconductor industry in particular, there is an ever-increasing need for smaller and more complex features at an ever-lower cost. Some examples of applications are sub-10 nm features for creation of FinFETs, lateral (horizontal) and vertical gate-all around nanowires, single electron transistors and advanced non-volatile memories (STT-RAM, MRAM, OxRAM, etc.). To address the challenge of patterning at sub-10 nm scale, novel patterning strategies must be envisioned. I will present the method of DNA (desoxyribonucleic acid) origami nanostructures self-assembly as a new approach. DNA origamis are built by programming the assembly of DNA molecules through base pairing. By virtue of its inherent small helix diameter (2 nm), DNA can be programmed to self-organize into various 2D and 3D morphologies at nano-scale resolution [1, 2]. Therefore, DNA is a promising mask material for bottom-up lithography techniques.

Although DNA origamis are limited in size (from tenths to a hundred nanometers), micron-scale patterning and high molecular weight objects are obtained through binding of numerous origamis [3, 4]. Shape-complementarity is a powerful way of connecting DNA nanostructures, allowing to create reversible binding systems [5]. By using this feature, we aim to develop new self-assembly capabilities to transfer desired nanometric patterns with a resolution up to sub-10 nm.

[1] P. W. K. Rothemund, “Folding DNA to create nanoscale shapes and patterns”, Nature, vol. 440, n° 7082, p.297-302, March 2006, doi: 10.1038/nature04586.

[2] S. M. Douglas, H. Dietz, T. Liedl, B. Högberg, F. Graf, W. M. Shih, “Self-assembly of DNA into nanoscale three-dimensional shapes”, Nature, vol. 459, p. 414-418, June 2009, doi: 10.1038/08016.

[3] G. Tikhomirov, P. Petersen, L. Qian, “Fractal assembly of micrometre-scale DNA origami arrays with arbitrary patterns”, Nature, vol. 552, p. 67-71 December 2017, doi: 10.1038/nature24655.

[4] Y. Ke, L. L. Ong, W. M. Shih, P. Yin, “Three-dimensional structures self-assembled from DNA bricks”, Science, vol. 338, p. 1177-1183, Novemer 2012, doi: 10.1126/science.1227268.

[5] T. Gerling, K. F. Wagenbauer, A. M. Neuner, H. Dietz, “Dynamic DNA devices and assemblies formed by shape-complementary, non-base paring 3D components”, Science, vol. 347, p. 1446-1452, doi: 10.1126/science.aaa5372.