Using biomolecules with micro and nanosystems: electrically aligned microtubules as a foundation for further integration

Ruben Ramalho[a,b,*], *Helena Soares*[a,c], *Susana Cardoso*[b,e], *Luís V. Melo*[b,d]
[a]*Instituto Gulbenkian de Ciência, R. da Quinta Grande 6, Oeiras, Portugal*
[b]*Instituto Superior Técnico, Av. Rovisco Pais, Lisboa, Portugal*
[c]*Escola Superior de Tecnologia de Saúde de Lisboa, Lisboa, Portugal*
[d]*IN, Lisboa, Portugal*
[e]*INESC-MN, R. Alves Redol 9, Lisboa, Portugal*
**rubendrr@igc.gulbenkian.pt*

Proteins in living cells are excellent examples of highly efficient nanodevices, whose functions are not limited to catalysing and participating in chemical reactions, but also include structuring the cell – often by self assembling into specialized structures such as those that make up the eukaryotic cytoskeleton – and generating forces used for intracellular transport, cellular remodelling or cellular motion (or, in fact, motion of the entire organism). A good example are microtubules, self-assembling anisotropic cytoskeletal polymers, which form a network that interacts with many of the cell's proteins and structures, including motor proteins – responsible for intracellular transport – and other cytoskeletal structures. This makes them a possible foundation for integrating and controlling other biomolecules.

When attempting to use these molecules with existing micro- and nano-electronic technology, there is a challenge in organising and controlling them. With this challenge in mind, we have previously shown [1] that microtubules can be aligned in bulk by a high electric field (~ 400 KV/m).

To study the possible use of microtubules in bionanotechnology, we have reproduced the previous bulk alignment experiment on a custom-made chip containing thousands of separate alignment experiments over distances in the order of 5 to 20 μm, which allowed us to use fields up to 1 MV/m. Using Atomic Force Microscopy, we observed the successful alignment of microtubules by the applied field, and present the results here.

To continue exploring the possibilities of this method, we have produced a simplified glass chip to be used with an optical microscope in order to further characterize microtubule alignment and interaction with associated proteins. The preliminary results from this chip will also be presented.

References:

[1] Ramalho, R., Soares, H. & Melo, L., *Mat. Sci. Eng. C*, **27**(2007), 1207-1210