

Artificial Biomolecular and Cellular Devices

"A Demand"

Recent advances in genomics and proteomics has created an acute need for reliable and miniaturised patterning for biomolecules, DNA fragments and proteins or peptides, respectively. Moreover, more "classical" high-tech markets, such as biosensors, require today a new generation of advanced bio-patterning techniques. Spatially-addressable polymer surface functionalisation also found applications in cell and tissue engineering and artificial organs.

How it is done?

Bioactive molecules and living cells are used as blocks for building biomolecular and/or cellular architectures on polymeric surfaces. The "fabrication" process employs exactly the same materials and technology used in semiconductor manufacturing technology. The "only" difference, from a technological point of view, is that the construction proceeds in a bottom-up manner instead of the classical top-down manner of the semiconductor chip manufacturing.

Example applications

Technologies For Bioinformatics.

These fall into the category of combinatorial chemistry. Several techniques for screening the genome of the organisms (most notably, Human Genome Project) are in use. The integrated bioinformatics technologies are on a stage similar to the early stages of Apple and IBM PC development some 10-15 years ago. Due to the rapid advancement of the demand these technologies and associated tools are far from being mature.

Combinatorial Screening Of Cell-active Chemical Species.

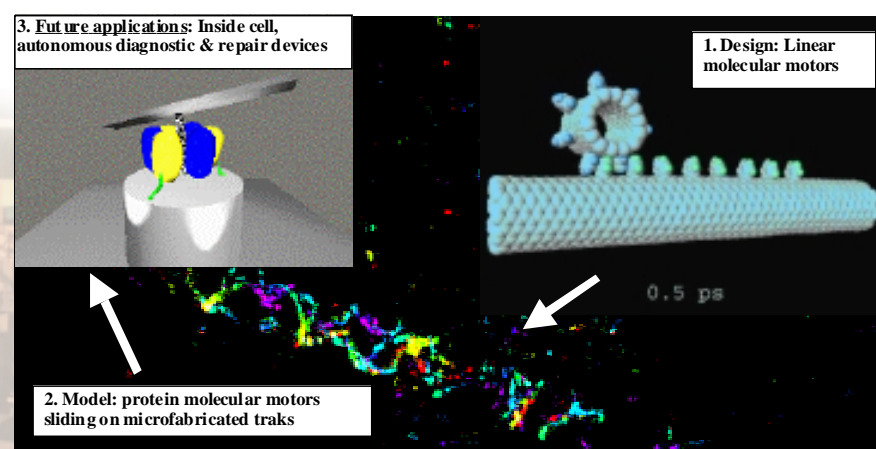
Chess-like arrays of bioactive molecules (peptides, proteins, antibodies, etc.) grafted on polymer surfaces and presented to in-vitro cultures of living cells (e.g neuronal, epithelial) with potential applications in the formulation of polymer-drug pairs for drug release, for drug systems targeting a specific organ/cell type, or for biomaterial screening for organ prosthesis.

Neuronal Cell-based Integrated Devices.

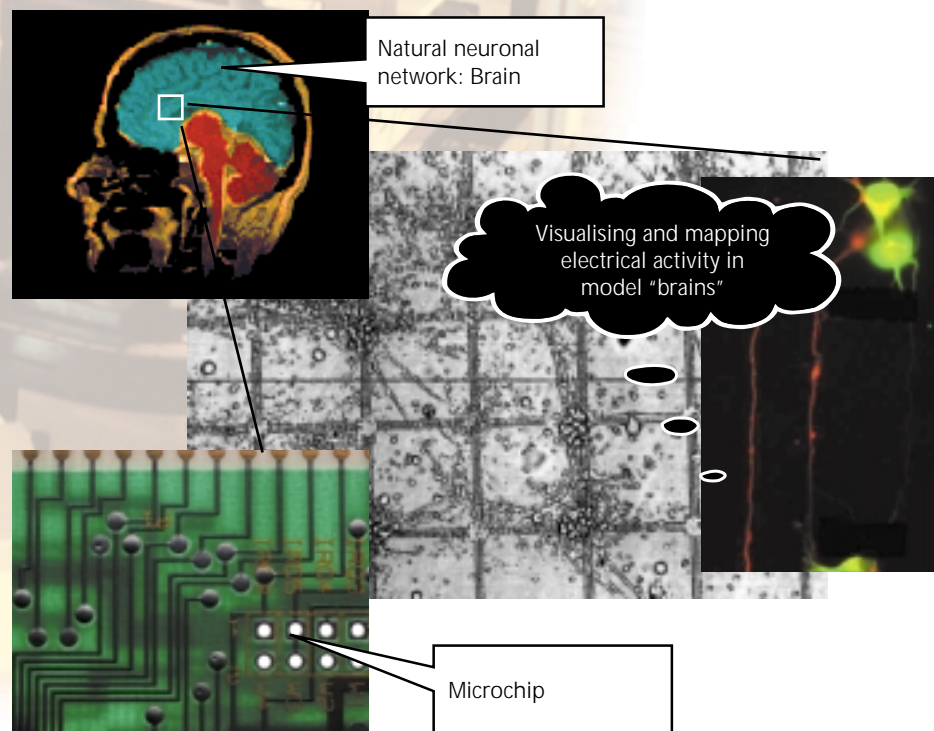
Polymer surfaces patterned with neuropeptides/ligand molecules may be used as "scaffold" for neuronal cells artificial networks. The precise, specific and "natural" positioning of the neuronal axons on top of a field-effect transistor gate will allow the detection of the currents flowing along neuronal axons by the FET device, or induced by changes in the gate voltage.

Advanced Biodevices Based On Protein Molecular Motors.

These devices could transform the chemical energy in mechanical, electrical or optical energy. Previous research showed that the movement of the protein molecular motors can be confined on protein functionalized "tracks" fabricated via bio-microlithography. The architecture of the dynamic device will consist in patterned protein "molecular motors" (e.g. active ends of myosin or kinesin). The mobile elements (e.g. actin filaments or microtubules, respectively) will move on patterned tracks using the energy generated by the ATP-ADP cycle.



Colour encoded trajectory of protein molecular motors moving on 10mm tracks



Network of neuronal cells on peptide-functionalised polymer surfaces