# PROTEIN INTERACTION WITH NANOSTRUCTURED SURFACES

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One of the major challenges for the development of analytical devices for biological analysis relies on the ability to design advanced surfaces with controlled interaction with the biological entities[1,2]. Surface functionalization techniques provide those bio-interfaces: appropriate surface physico-chemical properties are able to control the conformation and activity of the immobilized biomolecules. The subsequent technological step is the combination of different bio-functions in micro- and nano-patterns on the surfaces. For instance, structuring the surface in adhesive and non adhesive zone in order to preferentially guide the cell growth is one of the most promising tools for the development of cell chips and for tissue engineering[3].The requirement of further integration scales and the study of the special behaviour of the biomolecules interacting with nanostructured materials have been the two main motivations for the development of submicron patterning techniques[4]. For instance a strong increase of magnitude of sensitivity in biosensing devices together with lower detection limits have been demonstrated[5-6].
Plasma assisted déposition and etching techniques are interesting methods to produce functionalized surfaces with controlled micro- and nano-patterns: they provide high-level functionality with good stability on different substrates and are compatible with different micro- and nano-patterning techniques.
In this work we show some examples of micro- and nano-functional surfaces provided by plasma processes and self assembled monolayers in combination with Electron Beam Lithography and Colloidal lithography, and their application as platforms for molecular detection. In particular, micropatterned surfaces were produced by a spatial arrangement of different functional domains by a combination of plasma polymerisation and electron beam lithography: non-fouling patterns were made of poly(ethylene oxide) (PEO)-like polymers obtained by pulsed plasma polymerization of diethylene glycol dimethyl ether while fouling surfaces were composed of Poly-acrylic acid (PAA) from acrylic acid monomer obtained by plasma polymerization, and stabilised by electron beam. PAA nanopillars of 150nm diameter can be obtained in a PEO non-fouling background. Adsorption of IgG on those surfaces show that the protein adsorbs on the pillars, which results in a higher detection sensitivity in an immunoreaction with anti-IgG. On the other hand, nano-patterns of fouling-antifouling areas have been produced by combining Colloidal Lithography techniques with plasma deposited thin films and SAM's: in particular carboxylic functionalized nano-spots in a PEO-like anti-fouling matrix have been produced. We show that these chemical nano-patterns are able to immobilize proteins selectively in the carboxylic functional nano-domains, leaving the anti-fouling matrix clear. Moreover Enzyme-Linked Immunosorbent Assay and SPR imaging experiments were set-up showing that nano-patterned surface constrains the immobilization of the antibodies in a biological reactive configuration, thus significantly improving the device performances as compared to more conventional non-patterned or disordered patterned surfaces. We show with different methods (SPR, QCM, ELISA) that the detection sensitivity improvement increases as the size of the patterns decreases and that this effect is associated to the immobilisation of proteins at the boundaries of the patterns.

**References**

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