FUNCTIONAL SURFACES AS POWERFUL TOOL TO CONTROL
THE SURFACE-BIOMOLECULE INTERACTION

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The selective and reliable control of the interaction of biomolecules with a polymer phase such as an organic functional layer and solid substrates is one of the major topics in current developments\(^1\). In this context, nanobiotechnology can be seen as a young and rapidly developing field at the crossroad of biotechnology and material science which is able to solve problems with the utilisation of novel biological assays\(^2\).

Several methods of polymer modification are the toolbox for the generation of functional layers with specific characteristics in order to be able to meet the needs of the applications such as tissue culture or microarray technologies\(^3\).

In addition, the combination of thin functional layers with nanostructures can be the solution to overcome the remaining challenges and to provide the best possible platforms to be able to open the gate to new applications and assays\(^4,5\).

The present main focus of product developments comprises:

OPTIMISATION OF CELL ADHESION OF SENSITIVE CELL LINES

In general the propagation of cells and tissue in vitro can be challenging and therefore synthetic surfaces to support the cell cultivation are of great interest\(^6\). Cell-cell and cell-extracellular matrix (ECM) adhesion is a complex process which plays a fundamental role in cellular functions such as motility, proliferation, differentiation as well as apoptosis. Despite enormous progress in the field of cell surface interactions during the last decade, we still have limited understanding of the mechanism of cell adhesion. Despite that, the advanced technical opportunities from most recent developments in the field of material science and surface functionalisation open novel pathways to establish new cell based assays. These non-biological polymer modifications are mimicking the cellular surrounding to positively influence the cell adhesion (improved as well as minimised cell adhesion). Likewise, the risk of cross reaction or contamination is minimised compared with the state of the art coatings of matrix specific proteins.

![Figure 1: Long-term adhesion after 48 hours of SK-N-MC cells (40X magnification): standard cell culture treated surface (left), Advanced TC™ (middle) and PDL coating (right).](image)

THE WAY OF MINIMISING THE CELL ADHESION (cell repelling surface) is of interest in the field of stem cell research. To be able to meet this need, the successful surface has to prevent any interaction with cells (ionic, covalent coupling, hydrogen bonding) together with the need to be sterilised without loss of performance with the state of the art methods such as e-beam or gamma sterilisation. In comparison with the functional layers to improve the cell adhesion, interfaces to minimise the cell adhesion differ significantly in their chemical composition in order to meet the needs of the operator\(^7a,b\).

![Figure 2: Tumor cell spheroids grown in a 96 well U-bottom CELLSTAR® cell culture microplate with cell-repellent surface.](image)
Protein resistant surfaces are especially important for biosensoric applications, e.g. protein analytics and biomedical coatings. The control of the interface interaction of proteins acts in a similar as in the case of the cell repelling functional layers and therefore the synthetic pathway for the generation of these layers is alike.

**COVALENT IMMOBILISATION OF BIOMOLECULES**

Fluorescence-based techniques achieved widespread acceptance in many biochemical assays in the recent past. For detecting very small amounts of analyte, fluorescence molecules are versatile tools and are therefore exploited as signal transducers. As a consequence the covalent immobilisation of fluorescent dye labeled antibodies, proteins and DNA became a topic of great interest with the microarray technology. A challenge here is the synthesis of a surface with a suitable contact angle for an optimal spot morphology, a high binding capacity to reach a satisfying sensitivity as well as reduced non-specific binding. The solution and alternative to the first generation SOL-GEL layers are organic 3-D architectures with 20-50 nm thickness. With these platforms of outstanding binding capacity the microarray technology can be used in many applications such as genotyping in clinical diagnostics and expression profiling.

In addition Greiner Bio-One provides a unique multifunctional surface, which allows the ionic as well as the covalent coupling of biomolecules. By incorporating both amino and aldehyde moieties, the same polymer substrate can be used for several screening formats, such as DNA microarrays, protein microarrays and other screening applications. Therefore, the multifunctional HTA™Slide is an ideal cost saving tool for screening applications[8].

The good spot-morphology and homogeneity which can be achieved with multifunctional HTA™surfaces can be deduced from Figure 4.

In terms of microarray signal, there are many factors that can impact spot signal intensity such as target quality, feature diameter, probe quantity. Another important aspect is the influence of the background induced by the microarray processing or the microarray platform. One way to get an optimum of signal intensity combined with the minimised background is the use of reflective coatings such as gold or chromium layers with a layer thickness of approximately 40-60 nm.
The expression, purification and especially the crystallisation of membrane proteins is exceptionally demanding. Hydrophobic materials can be considered as a reliable solution to overcome the existing challenges in the field of protein crystallisation. The reliable and stable, biocompatible, hydrophobic surface can be the crucial benefit for the crystallisation of membrane proteins in small volumes and in buffer solutions with certain detergents. The properties of a hydrophobic surface efficiently counteract the potential spreading of sample droplets caused by added surfactant precipitants or detergents.

Figure 6: CrystalQuick™ Plus protein crystallisation plates reduce the risk of contamination via creeping due to a low meniscus in the reservoirs.

Figure 7: Reliable spot morphology of detergent-containing nanoliter drops ensure optimal crystallisation conditions as well as ideal crystal location for the analysis. Images of 100nl drops containing 50mM n-Octyl-Glucoside are courtesy of Karl Harlos, The Wellcome Trust Centre for Human Genetics, Oxford (UK).

These manifold developments prove the profit of surface modification for biotechnology and biomedical applications. Upcoming challenges will deal with biocompatibility and the enhanced use of these techniques in medical devices.


